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LNCS 11937

Innovative Technologies and Learning

Second International Conference, ICITL 2019
Tromsø, Norway, December 2–5, 2019
Proceedings

Springer

Lecture Notes in Computer Science 11937

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ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-030-35342-1 ISBN 978-3-030-35343-8 (eBook)
https://doi.org/10.1007/978-3-030-35343-8

LNCS Sublibrary: SL3 – Information Systems and Applications, incl. Internet/Web, and HCI

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The International Conference of Innovative Technologies and Learning (ICITL 2019) provided a platform for those who are working on educational technology to get together and exchange experiences. Benefited from using a variety of emerging innovative technologies, the e-learning environment has become highly diversified along the way. Diversified innovative technologies have fueled the creation of advanced learning environments by adopting appropriate pedagogies. Moreover, those technologies not only facilitate learning but also actively help students reach maximized learning performances. However, due to the rapid evolution of new technologies, how to make use of those technologies by complying with effective pedagogies to create adaptive or smart learning environments has been always in demand. Therefore, this conference intended to provide a platform for those researchers in education, computer science, and educational technology to share experiences of effectively applying cutting-edge technologies to learning and to further spark brightening prospects. It is hoped that the findings of each work presented at the conference have enlightened relevant researchers or education practitioners to create more effective learning environments. ICITL is always ready to share their works with the public.

This year's conference was held at the Department of Education, UiT the Arctic University of Norway. The university, which is on an urban island, is located to the north of the Arctic Circle in Tromsø. This year we received 189 submissions from 19 countries worldwide. After a rigorous double-blind review process, 85 papers were selected as full papers and 4 papers were selected as short papers, yielding an acceptance rate of 47%. These contributions covered the latest findings in the areas, including: (1) Application and Design of Innovative Learning Software; (2) Artificial Intelligence and Data Mining in Education; (3) Augmented and Virtual Reality in Education; (4) Computational Thinking in Education; (5) Design and Framework of Learning Systems; (6) Educational Data Analytics Techniques and Adaptive Learning Applications; (7) Educational Data Analytics Techniques and Adaptive Learning Applications; (8) Evaluation, Assessment, and Test; (9) Innovative Learning in Education; (10) Mobile Learning; (11) New Perspectives in Education; (12) Online Course and Web-based Environment; (13) Pedagogies to Innovative Technologies; (14) Social Media Learning; (15) Technologies Enhanced Language Learning; and (16) Technology and Engineering Education. Moreover, ICITL 2019 featured two keynote presentations and two invited speeches by renowned experts and scholars: CEO, Dr. Tommy Nordeng, Prof. Chi-Cheng Chang, Prof. João Barroso, and Prof. Frode Eika Sandnes. They brought us an insightful look into the interplay between "Students' Conceptions of Learning and "Curriculum in an Open World."

We would like to thank the Organizing Committee for their efforts and time spent to ensure the success of the conference. We would also like to express our gratitude to the Program Committee members for their timely and helpful reviews. Last but not least, we would like to thank all the authors for their contribution in maintaining a high-quality conference – we count on your continued support in playing a significant role in the Innovative Technologies and Learning community in the future.

December 2019

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Contents

Application and Design of Innovative Learning Software

Increasing Students' Interest and Learning Achievement Using Cooperative Learning (Students Team Achievement Division) Through Edmodo

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Abstract. One of the models that encourage active learning, self-reliance and self-responsibility in students is STAD (Student Teams Achievement Division) cooperative learning model through Edmodo. The application of this model is expected to improve student learning interest and achievement. The objectives of this study were: (1) Improving student learning interest in Cross Culture Understanding (CCU) course through the implementation of STAD cooperative learning models using Edmodo, and (2) Improving the achievement of students in Cross Culture Understanding (CCU) course through the application of STAD cooperative learning model using Edmodo. The participants are 37 college students in International Business Management. The result showed: (1) students' learning interest, in general, has increased. Before implementing STAD using Edmodo, students' learning interest was less than 50. After the model applied then in the first cycle students' learning interest increased by 77.5% and increased again in the second cycle to 87.78%, and (2) the increasing percentage of competence in Cycle II of 87.78% compared to 64.86% in the first cycle by using the model of STAD Cooperative Learning. In conclusion, the student team achievement divisions technique can be applied through Edmodo to enhance students' interest and learning achievement on the CCU course successfully.

Keywords: Cross Culture Understanding (CCU) · Cooperative learning · Student Teams Achievement Division (STAD) · Edmodo · Increased competence

1 Introduction

Speaking English allows people to broaden the world, from job opportunities to the ability to relate to people from every country with different cultures. Culture is the characteristics and knowledge of a particular group of people, encompassing language, religion, cuisine, social habits, music and arts [1]. Cross-cultural communication has become strategically important to companies due to the growth of the global business, technology, and the internet. Graduates who want to compete in working and having a

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 3–13, 2019.
https://doi.org/10.1007/978-3-030-35343-8_1

career in international business need to enrich the knowledge of CCU. Therefore, cross-cultural understanding and sensitivity are increasingly being viewed as important objectives for both educators and researchers [2].

Scholars have suggested that it is not easy to attain cross-cultural understanding and intercultural competence among students due to language barriers [3] because they rarely interact with those who are culturally different [4]. Shadiev and Huang [5] mentioned language barriers, suggesting that when students do not have a common language, this issue hampers interaction.

Furthermore, there has not been much attention paid to cross-cultural understanding and intercultural sensitivity, especially regarding how they emerge and develop [6]. Participants from different countries and different linguistic backgrounds (native languages) were selected for this study, as they were seen to offer the diverse cultural background that was the core of the study design [4].

Cross Culture Understanding (CCU) is a study taught in English in the International class in Polytechnics in Indonesia. Students learn, explore and understand cultural differences among countries. In this course, students learn how to deal with differences regarding the culture and rules applied in a society or country so cultural misunderstandings can be avoided. One of the most common causes of misunderstandings about culture is the existence of miscommunication and misinterpretation of meaning between different communities culture. Therefore, with CCU course, the students improve the ability to understand the differences between cultures to avoid cultural misunderstandings. However, there are still unsatisfactory results because students feel the learning process less interactive provided by the lecturer. The majority of learning done in Indonesia is more teacher-oriented. Students are still not active in learning activities because, during learning, lecturers often focus on the material so that activities carried out by students are usually only listening and recording. Students rarely ask questions or express opinions. Intergroup discussions are seldom carried out, so that interaction and communication among students and lecturers are still not established during the learning process. Therefore, teachers need to improve the learning process for students so that they can take an active role during the learning process.

One learning model that further encourages interest, activity, independence and responsibility in students is the Cooperative Learning (CL) model type STAD (Students Teams Achievement Division). CL is mainly based on the notion that the best way to learn a language has small heterogeneous groups in which all students collaboratively and cooperatively work towards a common objective [7]. Combining cooperative learning and the growing popularity of learning system for use in educational purposes has become an international phenomenon. Edmodo, as one of the learning system, allows for the use of various educational applications. It is a free social learning network offering sharing resources, communication, and collaboration for students, teachers, and alike. Besides supporting text messaging, alert boards, blogs, and uploading file, Edmodo also facilitates networking with useful contacts and access to resources for students to fulfil their potential.

The research questions are as followed:

1. Increase student's interest in Cross Culture Understanding (CCU) course through the application of the cooperative learning type STAD using Edmodo.

2. Improve student achievement in Cross Culture Understanding (CCU) course through the application of the cooperative learning type STAD using Edmodo.

2 Literature Review

2.1 Cooperative Learning (CL)

Cooperative Learning is part of a group of teaching/learning techniques where students interact with each other to acquire and practise the elements of a subject matter and to meet common learning goals. It is much more than just putting students into groups and hoping for the best [8]. Students study together in a group to reach their learning goals through discussion and peer feedback in CL.

CL would inspire students to have higher accomplishment than individualistic or competitive learning because CL offers students various opportunities that empower them to develop their self-esteem and also to be intrinsically motivated. Indeed, a large number of studies investigated the advantage of CL in language teaching [9–13].

Mehdizadeh, Nojabaee, and Asgari [14] believed that students' creativity could be significantly enhanced in a milieu wherein socio-cultural diversity, teamwork, independence, intrinsic-motivation, and risk-taking principles that tolerate and even inspire failure are fortified. According to them, one of the methods, which improves students' creativity, can be cooperative learning as it has proven to have positive impacts on students' achievement.

Many studies indicate that persons involved in cooperative learning show a more significant effort to achieve than persons involved in learning on their own, that is, when not learning in a group/as part of a team [15–17]. In the learning process, students are allowed to work in small groups to discuss and solve problems. Group assignments can encourage students to work together in integrating new knowledge with the knowledge they already have. For mastering the subject matter, each student in the group is jointly responsible by discussing, exchanging opinions, knowledge and experiences. The ability or achievement of each group member greatly determines the results of group learning achievement, for that mastery of each student's subject matter is emphasised in cooperative learning strategies. With the cooperative learning model, students are expected to develop all their potential optimally by active thinking during the learning process. Moreover, Macpherson [8] mentioned that Cooperative Learning models consist of fundamental principles as follows:

- Group tasks are designed to be suitable for group work.
- Positive interdependence is built in – cooperation is necessary for students to succeed.
- Attention and class time are given to the interpersonal/cooperative skill-building.
- Participants learn together in small (2–5 member) groups.
- Students are individually accountable for learning and participation.
- The instructor's role changes from being the "sage on the stage" to the "guide on the side."

Cooperative Learning is about moving from rote learning to learning how to think critically and in changing circumstances.

2.2 Students Team Achievement Division (STAD)

Students' Team Achievement Division known as STAD, is one of many teaching methods in cooperative learning [18]. Team recognition is intricate through STAD. It also stimulates group responsibility to foster individual learning [19]. A team in STAD is a group consisting of four or five students representing the heterogeneity class regarding performance, the tribe, and gender [20]. According to Nur [20], STAD consists of five main components, namely the presentation class, teamwork, quizzes, score repair individual and team awards.

a. Class Presentation

This presentation most often uses direct teaching or lectures conducted by lecturers, but presentations can include audio-visual presentations or group findings [20]. In this activity, students must focus on class presentations because then they will help them do the quiz well. Moreover, the quiz scores they get will determine the score of the team.

b. Teamwork

In each group consisted of four or five heterogeneous students based on learning achievement, gender and ethnicity. After the lecturer presented the material, the team gathered to study the material provided by using a worksheet. At this stage of group work, students jointly discuss problems and help among members in their groups. The most frequent team-work is to correct any mistakes or misconceptions if a fellow team friend makes a mistake.

c. Quiz

To what extent student success in learning can be known by holding a quiz given by lecturers regarding the material discussed. In working on this quiz, the student must work individually even though the score he gets later can be used to determine the success of the group. To each, the lecturer gives a score that is used to score together for each group.

d. Individual Remedial Score

Scores obtained by each member in the quiz, contribute to their group, and are based on the extent to which their scores have increased, compared to the initial average scores that they have achieved before [21]. Based on the original score of each, the improvement or development score is determined. The average improvement score of each in a group will be used to determine the award for the achievement group.

e. Team Award

Groups can obtain other certificates or awards if the average score obtained exceeds specific criteria. The awards obtained indicate the success of each group in establishing cooperation between group members. Group awards are carried out by giving awards in the form of certificates or other awards for the effort and hard work of the group.

2.3 Student Interest and Learning Achievement

According to Cambridge Dictionary [22], the definition of interest is the feeling of wanting to give your attention to something or of wanting to be involved with and to discover more about something and, activeness is defined as a thing or situation where students can be active. To achieve excellent performance takes not only intelligence but also a growing interest in student's learning. Interest is the relationship between self and something outside of ourselves" [23].

Learning is one of the bases to find out the extent to which lecture material delivered by lecturers can be accepted and understood so that student learning achievements can be known from the results of the tests given. Achievement is the result that has been gained from what has been done optimally. According to [24], several factors influence learning achievement, namely internal factors and external factors. Internal factors include health, intelligence, talent, interest, and motivation, while external factors include family, school, community and the surrounding environment.

2.4 Edmodo

Edmodo is a social media platform that is often described as Facebook for schools and can function more as needed [25]. Edmodo is an interesting application for lecturers and students with social elements that resemble Facebook, but there are high values in social networking-based educational applications. Edmodo, which is also cloud-based collaboration is an application that is quite safe to be used by lecturers and students because it can be easily managed as a system that provides the best and practical features that can eliminate our anxiety about activities students usually do with the internet especially "Facebook" [26].

Edmodo is the most secure and reliable social network platform supporting educational activities [27]. Its functions are enriched with analytical tools enabling the monitoring, assessment, and management of students [28]. It is one of network platform which enables teachers and students to connect, collaborate and share content and educational applications, and assess homework, grades, class discussions and notifications. Its purpose is to help educators harness the power of social media to customise the classroom for every learner. Realising the high potentials of this learning style, Edmodo could be a practical solution to be implemented in the classroom in a blended learning way.

With the Edmodo platform, it will be easier to control interactions between students in the Edmodo learning environment [25]. No one can enter a group (class) if students do not know the group code, and students cannot use it to connect with strangers as happened on "Facebook". We will quickly find out if some violators or foreigners are registered in the group (class) that managed with Edmodo. The implication of Edmodo for learning is, it is like other learning aids which are an online platform to encourage lecturer learning, or it can be a more creative way to involve students in collaborative learning [26].

Edmodo is a pathway for students to interact with their colleagues and lecturers in an academic atmosphere, students can carry out activities such as downloading lecture material, discussing between students and lecturers, answering assignments or quizzes without having a face-to-face meeting with lecturers who can generate excitement in the learning process that can overcome new and challenging material will increase. The use of Edmodo can also teach students how to behave online and are responsible for managing their learning activities with systems that are guaranteed safe [26].

3 Research Design

3.1 Participants

The participants of the research were 37 students of International Business Management who took CCU course. The research was taken during the regular class of semester seven from March until July 2017 in Semarang State Polytechnic, Indonesia. The participants were divided into seven groups of 4 and three groups of 3.

3.2 Experiment Procedure

The instruments used in this class action research were the assessment format, performance test format, mid and final test, student worksheets, and observation questionnaires for assistants and lecturers. The object of this study is the application of the STAD type cooperative learning model using the Edmodo.

The teaching strategies in this study is classroom activities and cooperative learning with Edmodo after class. The classroom activities include a personal presentation on the topics in CCU course, group discussion and group presentation. The teacher gave topics of CCU course to a group of students who were divided randomly. Each student in a group presents a different topic for maximal 1 min. After that, group discussion and group presentation on the Edmodo. Each student in a group can discuss on line, and between-group can discuss and give feedback to each other. Moreover, the teacher also gives comments or feedback online, both personal and group performance. Finally, the teacher collected all personal and group assignment.

This type of research is classroom action research conducted collaboratively. In collaborative research, the party that takes action is the lecturer himself while the one who is asked to observe the ongoing process of action is the researcher [29]. According to Kemmis and Taggart, there are several stages in this study [30].

This study carried out in two cycles. The cycle is stopped if the class conditions are stable in this case the lecturer can master new learning skills and students are familiar with the STAD type cooperative learning model and the data displayed in the class is saturated in the sense that there is an increase in student activity and learning achievement [30]. Figure 1 shows the flow of research.

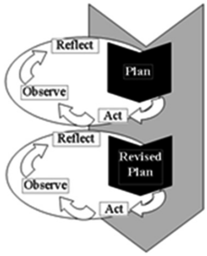

Fig. 1. Spiral model by Kemmis and Taggart

3.3 Data Analysis

The researcher summarises the values obtained by students, which are then divided by the number of students in the class to obtain the class average.

$$\bar{X} = \frac{\sum X}{\sum N} \tag{1}$$

Note:

$\bar{X}$ = Mean score
$\sum X$ = Total Score
$\sum N$ = Total students

There are two categories to find out student competencies, namely individually and classically. Based on the instructions for the implementation of the curriculum teaching and learning [31], a student is considered as 'competence' if he/she has achieved a score of 65% or 65, and the class is said to be 'competence' if 85% of the class have achieved more than/equalled 65%.

4 Result

Before this class action research was carried out, the teacher applied the learning activity with traditional approaches by using the lecture method, taking notes, then allowing students to study and written tests. Learning using conventional methods seems to have no active role for students, only about 21 out of 37 students or approximately 50% were active. The low percentage that plays an active role in this learning has an impact on the low learning outcomes of CCU. The cross-cultural course learning outcomes from the daily I quiz score were the highest 76, the average score was 51, and the lowest was 25. While the number of students whose learning outcomes met the minimum competency standards was eight students or 37.5% Learning using conventional methods, where students are not actively involved, has implications for relatively low learning outcomes. The research was done in 2 cycles with cooperative learning, STAD and Edmodo.

4.1 Cycle 1

The actions carried out in this first cycle constitute the realisation of the planned activities that have been prepared covering the first, second, third, and fourth activities. Every implementation of face-to-face activity was observed by the researcher and colleague (team teaching). The written test was held on understanding the concept of discussion activities in the scope of the CCU for students in STAD learning. Table 1 showed the results that were obtained.

Table 1. The percentage score of aspects of understanding the concept of discussion activities about CCU course with Type STAD in the first cycle

No	Categorize	Score	Respondents	Percentage	Classical result
1	Special	91–100	0	0	*Mean* = 74,56
2	Very understand	81–90	0	0	Percentage = 64,86%
3	Understand	71–80	24	60	Categorize = Understand
4	Average	61–70	13	40	
5	Poor	51–60	0	0	
6	Lack	41–50	0	0	
7	Bad	0–40	0	0	
Total			37	100	

A maximum score of aspects of understanding the concept of modernisation of students is 100%.

Table 1 showed that only 64,86% of the students were categorized as 'Understand'. It means the result is not maximal. Moreover, the result of learning observation in this first cycle showed that students seemed to be not maximal in practising the CCU theory, it seemed that many students were hesitant and not fluent, there were some errors in pronunciation or memorisation. Reflection was done to review the result of Cycle 1. In general, learning using the Cooperative Type STAD approach can take place more effectively as indicated by the results of tests and non-tests mentioned above. However, in reality, there are still students even though the percentage is small, which does not participate actively in various activities carried out. Cycle 2 was done based on the reflection and observation result in Cycle 1 in order to get an improvement in the learning achievement.

4.2 Cycle 2

The action plan in cycle II is not the same as the action plan in the first cycle because there are several additional actions in this second cycle, namely by using the Edmodo. This is done to provide a solution for some inactive students, and 'ignorant' of the learning activities carried out. The addition can be two possible actions, namely: first, students who are recorded as inactive or just 'ignorant' in learning activities with the Cooperative Type STAD approach using the "Edmodo" method with the intention that they are motivated to complete the tasks assigned to them. Interdependent behaviour with other, more active friends has to be abandoned because there is no more active student who becomes a place to depend on completing the task. Everything must work because of the workload they have to complete together. On the online platform, everybody can see everybody whether they complete assignment, test, discussion. It meant that everybody should be active personally or in groups. Table 2 shows the result of cycle 2.

Table 2. The percentage score of aspects of understanding the concept of discussion activities about CCU course with Type STAD and Edmodo in the Second cycle

No	Categorize	Score	Respondents	Percentage	Classical result
1	Special	91–100	0	0	*Mean* = 77.78
2	Very understand	81–90	12	32,43	Percentage = 87.78%
3	Understand	71–80	19	51,35	Categorize = Understand
4	Average	61–70	6	16,22	
5	Poor	51–60	0	0	
6	Lack	41–50	0	0	
7	Bad	0–40	0	0	
Total			37	100	37

The observation results of learning in this second cycle, learning began to look fun and interactive. Students began to be more interested in the course of learning. The group discussion was running optimally and excitedly. The level of mastery in the CCU competency shows high results.

Academic achievement shown from the test scores experienced a significant increase; the activity of students also increased. Students are getting used to working together in learning (cooperative learning). Even though there were still six students who were ignorant and without reluctance in conducting discussions, maybe 6 of these students did not like to work together. Theoretically, some humans do not like cooperation, namely humans who are weak in *interpersonal* intelligence, while they are quite high in *intrapersonal* intelligence. Humans like this tend to be better able to learn independently compared to cooperation. So when there is a discussion activity, this human tends to be quiet as lazy, but if he is given the task of completing his tasks, this human can solve it well. Based on the reflection on the activities of the second cycle, the researchers concluded that they did not continue in the next cycle.

5 Conclusion

In general, the difference between the application of conventional learning models and Cooperative Type STAD appears. Even though there has not been a noticeable change, Cycle I has shown an increase in academic achievement that can be seen from the student test results. On the other hand, there is a change in behaviour where students are so enthusiastic, active, and capable of arguing. Therefore, the application of the

STAD Cooperative Type in class makes the classroom atmosphere more alive. Starting to appear as students as learning centre (students as subjects).

In Cycle II, by implementing the Cooperative Type STAD approach with Edmodo, there appear to be significant changes both regarding academic values and behavioural changes. Test results have increased, and there have been changes in behaviour; activeness, enthusiasm, ability to discuss. The classroom atmosphere grew lively. Students are increasingly accustomed to conducting learning activities by applying the Cooperative Type STAD approach with Edmodo. Old habits that sit still listen take notes, do not dare to ask have started to disappear.

Although in general, the changes that occur are quite significant, in reality, there are still students who have not been active, even indifferent, silent, and as if they do not dare to speak out even though the Cooperative Type STAD approach with Edmodo should stimulate them to be actively involved. Based on the theory of Howard Gardner [32], namely the theory of Multiple Intelligences, that there are humans who are weak in interpersonal intelligence but stronger in intrapersonal intelligence. Students like this do not like or cannot work together in learning. They tend to like working alone. They will be able to carry out their duties well when they are given assignments independently. How right a learning approach is, it will not be suitable for all humans. Lecturers should use a varied learning approach. However, in general, the Cooperative Type STAD approach with Edmodo is an alternative approach that can be applied to improve the quality of classroom learning.

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The Influence of Interactive and Non-interactive E-Book on the Learning Effectiveness of High and Low Achievement Nursing Students

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Abstract. This study aims to explore the influence of interactive and non-interactive e-books used in nursing education courses on the achievement of high achievement and low achievement students. This study used a quasi-experimental study design with two classes of students as experimental and control groups. Both two groups use the same learning materials. The results of the study show that both e-books have a positive impact on learning outcomes, but interactive e-books are more effective, and learning through interactive e-books is more effective for low-achieving students than for high-achieving students. It also means that this learning method can effectively narrow the gap between high and low students.

Keywords: Nursing education · E-Books · High and low achievement · Interactive

1 Introduction and Related Works

The progress of information technology has brought about changes in learning methods, diversified learning methods and rich learning contents [1]. E-learning has become the trend and direction of education and learning all over the world, and is prevalent in schools at all levels, even in governments and companies. Since the beginning of the 21st century, digital technology has infiltrated into everyone's life in an imperceptible manner, thus changing our life style and culture and even becoming an indispensable part. E-mail, social media, Internet TV, various applications, even Internet banking, and online shopping are all closely related to life. In recent years, the mode of e-learning has been upgraded from Web-based Learning (WBL) to Mobile Learning (M-learning) due to the update of carriers and technologies, and has progressed to Ubiquitous Learning (U-learning) through the progress of web-based technologies. Due to these changes, learners also need to learn to carry out various types of learning through different technologies and vehicles. Brown [2], pointed out that the construction of knowledge

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 14–23, 2019.
https://doi.org/10.1007/978-3-030-35343-8_2

needs interaction between environment and learners. Therefore, if students only study in a single scenario, their knowledge may be limited. In recent years, more and more information technology has been integrated into health care education. Through the introduction and integration of information technology, health care personnel can provide resources and services for health care education, and bring innovative application fields [3]. These new technologies, whether in education, clinic or work scenarios, can effectively enhance professional knowledge of health care personnel, improve quality of care for patients, and give patients different care experiences [4–7]. In relevant literature on actual introduction of information technology into health care or medical education, digital teaching materials are mostly compared with traditional teaching methods, and less compared with the same digital teaching materials [4, 6, 8]. These studies focused on effects and differences of various presentation methods on learners. Since the positive influence of e-books on learners has been proved in many literatures, this paper will pay attention to the different influence of e-books featuring the same content and different presentation method on learners.

Students have different learning achievements, and how to narrow the gap between high achievement and low achievement students has become the top priority for many teachers. Although high achievement students have better results and better understanding, their learning motivation and attitude are not necessarily better than low achievement students [9]. Han, Capraro, and Capraro [10] proved that the growth space of low achievement students is larger than that of high achievement students, and sound learning interaction would render better learning effect and understanding of low achievement students [11]. Hence, this study compared the correlation between and change in learning achievement and learning attitude of high and low achievement students after receiving interactive and non-interactive e-book teaching.

2 Method

2.1 Participants

The research subjects of this study are junior students majoring in health care in a national university in Taiwan. The course name is Community Health Care. Students of this study were divided into two groups, namely control group and experimental group, and were taught by the same teachers with the same teaching contents. The number of control group is 32 and the number of experimental group is 35, with an average age of 20–21. The teaching tools used by the control group were non-interactive e-books, which served as textbooks for learning; while the learning tools used by the experimental group were interactive e-books, which also served as textbooks for learning. The two groups received the same curriculum content, namely a total of seven chapters of community health care teaching materials. In terms of high and low achievements, students whose previous test scores were higher than the average were of high achievements, while the students whose scores were lower than the average were of low achievements.

The teacher of this study is a senior associate professor in the department of health care, who has many years of health care education experience and has written many health care related works. The teacher is mainly engaged in community health care, health care research, geriatric health care, community building, health promotion, etc., and is willing to use innovative teaching methods in curriculum activities.

2.2 Procedure

The experimental time for introducing e-books into health care education is nine weeks (from the beginning of school to the mid-term exam). The experimental time is three classes per week and one class is 50 min.

In the first week for the experimental group, the teacher explained the purpose and execution mode of courses and experiments, and then carried out pre-test. The pre-test topic was "Community Health Care Pre-test" given by the teacher, with a total of 50 questions. In the second week, a seven-week health care education experiment on e-book introduction was conducted. The experimental group used interactive e-books for learning. The teacher used WIFI to project contents on the tablet computer to the screen in real time, and employed the e-book note system to mark and remind the key points. In the process, students could also get more familiar with the operation of the tablet and e-book system. In the ninth week, students participated in a post-test with a test time of 50 min. The post-test topic was "Community Health Care Interim Test".

The research process of control group was similar to that of the experimental group. In the first week, the teacher conducted course description and pre-test. In this regard, the introduction of e-books into the health care education experiment was shifted from using non-interactive e-books for learning from the second week to the seventh week. Then, the same post-test was carried out in the ninth week. The research flow chart is shown in the Fig. 1:

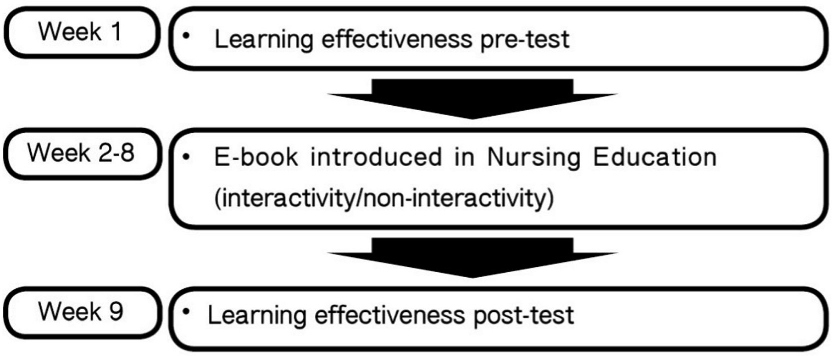

Fig. 1. Experiment procedure

2.3 System Introduction

The e-book system used in this research is "SimMagic eBook". The textbook is edited according to the discussion results between researchers and the teacher. The teacher provided the relevant materials of the course, and researchers collated, typeset and edited the materials into teaching materials. This section will introduce the e-book reading interface, e-book interactive function and e-book editing software. This e-book system contains multiple interactive functions that allow learners to interact with the e-book itself, including masks, scratchers, picture puzzles, slides, pop-up windows, etc. Simple test modules are built in, and the types of questions can be divided into click, filling, and link-game. Some questions can be added to the course content to review absorption of learners. The interactive features of e-books are shown in the figure, including link-game tests, masks, scratchers, pop-up windows, etc. (Fig. 2).

Fig. 2. System interface

2.4 Assessment Tools

The teacher set the topic of the learning effectiveness test with a range from chapter one to chapter seven of this study. As the subjects have taken health care related courses before this course, they already have a certain degree of knowledge. The pre-test and post-test questions were all multiple-choice questions with a total of 40 items. Google forms were used for students to answer questions and for the teacher to score on tablets. In the post-test, the same test paper was used for post-test of learning effect during the mid-term exam week.

3 Results

3.1 Learning Effectiveness Analysis

According to the learning effect test results of experimental group and control group, independent sample t-test analysis was conducted, and the results are shown in Table 1:

Table 1. Learning effectiveness pre-test of experimental group and control group.

	N	*M*	*SD*	*t*	*p*	*d*
E-Group	35	60.36	8.51	.057	.96	.015
C-Group	32	60.23	9.11			

Note. E-Group = Experimental group; C-Group = Control group

The results of independent sample t-test analysis show that there is no significant difference between the control group and the experimental group in pre-test results, and there was no significant difference between the experimental group students and the control group students in pre-class scores. After proving that there were no significant differences in pre-class achievement between the two groups of students, the independent sample t-test was then used to analyze the learning effects of the experimental group and the control group. The test results are shown in Table 2:

Table 2. Learning effectiveness post-test of experimental group and control group.

	N	*M*	*SD*	*t*	*p*	*d*
E-Group	35	85.57	8.96	2.91	$.005^{**}$	.73
C-Group	32	79.84	7.15			

$^{**}p < .01$

Note. E-Group = Experimental group; C-Group = Control group

As shown in Table 2, independent sample t-tests were conducted according to the post-test results of experimental group and control group, and it was found that there was a significant difference between the two groups. After-class results of the experimental group students were higher than those of the control group students.

The *t*-test analysis of dependent samples was carried out based on the results of pre- and post-test of control group. The results are shown in Table 3:

Table 3. Learning effectiveness tests of control group.

	N	*M*	*SD*	*t*	*p*	*d*
Pre test	32	60.23	9.11	−14.31	$.000^{***}$	2.17
Post test	32	79.84	8.96			

$^{***}p < .001$

According to the statistical results of t-test of dependent samples, the results of pre- and post-test of the control group are significantly different, indicating that the learning effect of control group is significantly different between pre-test and post-test. Next, the t-test analysis of dependent samples was carried out on the results of pre-and post-test of experimental group. The test results are shown in Table 4:

Table 4. Learning effectiveness tests of experimental group

	N	*M*	*SD*	*t*	*p*	*d*
Pre test	35	60.36	8.51	−12.94	.000***	3.21
Post test	35	84.57	7.15			

$^{***}p < .001$

According to the statistical results of t-test of dependent samples, the results of pre- and post-test of the experimental group are significantly different, indicating that the learning effect of the experimental group is significantly different between pre-test and post-test.

3.2 High and Low Achievement of Learning Effectiveness Analysis

In the control group, the average of pre-test results is 60.23, with 18 students being classified as high achievement, and 14 as low achievement. In the experimental group, the average is 60.35, with 17 students being classified as high achievement, and 18 as low achievement. The following statistics, made based on the minimum value, maximum value, average value and standard deviation respectively, show the pre- and post-test learning effect of high and low achievement students of the control group and the experimental group.

Table 5. Learning effectiveness tests of control group

	N	*Min.*	*Max.*	*M*	*SD*
Pre-test (HA)	18	62.5	77.5	65.42	4.3
Pre-test (LA)	14	32.5	60.0	53.57	9.39
Post-test (HA)	18	72.5	92.5	82.5	6.12
Post-test (LA)	14	50.0	95.0	76.43	10.95

Note: HA = High achievement; LA = Low achievement

According to the statistical results of Table 5, the high achievement students of the control group improved their test scores by 17 points after receiving the general e-book teaching, while the low achievement students improved by nearly 23 points after receiving the general e-book learning.

According to the statistical results of Table 6, the high achievement students of the experimental group improved by nearly 25 points after receiving interactive e-book learning, while the low achievement students improved by nearly 26 points after receiving interactive e-book learning.

Table 6. Learning effectiveness tests of experimental group

	N	*Min.*	*Max.*	*M*	*SD*
Pre-test (HA)	17	62.5	87.5	66.62	6.49
Pre-test (LA)	18	42.5	60.0	54.44	5.39
Post-test (HA)	17	85.0	97.5	91.32	3.66
Post-test (LA)	18	72.5	87.5	80.14	5.04

Note: HA = High achievement; LA = Low achievement

Next, the independent sample t-test was used to analyze the difference in the post-test scores between the two groups. The statistical results are as follows:

Table 7. Learning effectiveness post-test of two groups high achievement students

	N	*M*	*SD*	*t*	*p*	*d*
E-Group	17	91.32	3.66	5.14	$.000^{***}$	−1.74
C-Group	18	85.50	6.12			

$^{***}p < .001$
Note. E-Group = Experimental group; C-Group = Control group

The results of Table 7 show the significant difference in learning effect of high achievement students receiving interactive e-book learning in the experimental group and the control group, indicating that the impact of interactive e-books on learning effect is greater than that of general e-books.

Table 8. Learning effectiveness post-test of two groups low achievement students

	N	*M*	*SD*	*t*	*p*	*d*
E-Group	17	91.32	3.66	1.28	.211	−0.46
C-Group	18	85.50	6.12			

$^{***}p < .001$
Note. E-Group = Experimental group; C-Group = Control group

From the analysis results in Table 8, it can be seen that these two learning methods do not achieve significant learning effect for low achievement students. However, the average of low achievement students in the experimental group is still higher than that of low achievement students in the control group.

4 Discussions

Firstly, the statistical analysis of the impact of e-book learning presented in different methods on learning results was conducted for the whole students. Through the statistical results of Table 1, it can be found that after independent sample t-test analysis, the p value is greater than .05, and there is no significant difference. Based on this result, it can be inferred that there is no significant difference in the learning effect between the experimental group and the control group before the experiment. Therefore, after introducing e-books in teaching experiment, the two groups can compare the post-test learning effect and analyze the effect of the teaching experiment.

The statistical results of Table 2 show that after independent sample t-test analysis, the p value is equal to .005, which has reached a significant difference. Based on this result, it can be inferred that the learning effects of the experimental group and the control group have been significantly different after introducing e-books in teaching experiment. Among them, the performance of the experimental group using interactive e-books (M = 84.57, SD = 7.15), is significantly better than those of the control group (M = 79.84, SD = 8.96) using non-interactive e-books. The results also prove that interactive e-books are significantly better than non-interactive e-books in improving learning results. In addition, the standard deviation of the experimental group and the control group decreased after the teaching experiment, representing that the degree difference between students also gradually improved through the teaching experiment.

Table 3 analyzes the significance of pre- and post-test learning effect of the control group, and the p value is less than .001, reaching significant results. Table 4 analyzes the significance of pre- and post-test learning effect of the experimental group, and the p value is also less than .001, reaching significant results. The analysis results show that both the use of interactive e-books and the introduction of non-interactive e-books have a significant impact on students' learning effect, but the improvement of learning effect by interactive e-books is still slightly better.

Next, this paper discusses the statistics on the learning effects of high achievement and low achievement students. First, students of both high and low achievement in the experimental group and the control group have achieved remarkable growth in their learning effect after receiving e-book teaching, which means that e-book teaching can enable students of different levels to learn efficiently in health care education. However, according to the research results of the control group, the progress of high achievement students is smaller than that of low achievement students. It can be inferred that space for high-level students to make progress is smaller, and the pre- and post-test gap between high achievement students and low achievement students is also reduced from 12 points to 6 points. This result can prove that e-book learning can shorten the learning gap between students of different levels. According to the research results of the experimental group, students with high and low achievements have improved by 25 points and 26 points respectively in their pre- and post-tests. Although the progress is similar, the standard deviation of students with high achievements has decreased from 6.49 to 3.66, which shows that the use of interactive e-books for teaching can effectively narrow the gap among students with high achievements.

The statistical results of the control group and the experimental group are cross-compared. In the high achievement group, the improvement of the experimental group using interactive e-books is obviously much larger than that of control group. In addition, based on the comparison of pre- and post-tests, the standard deviation of the control group increases, while the standard deviation of the experimental group decreases, which indicates that the addition of interactive function enhance learning effect of students and reduces the gap between students. In the low achievement group, the benefits brought by interactive e-books are even greater. The scores of the low achievement students of the experimental group who have improved by nearly 26 points are close to those of the high achievement students of the control group. The same conclusion is reached in terms of standard deviation. The standard deviation of the control group increases, while the standard deviation of the experimental group decreases. Based on the statistical results of the two groups, it can be inferred that e-book learning methods do have significant and positive results for health care education, which are consistent with the results of relevant literature [7, 12–15], and may narrow the gap between learners of different levels. The addition of interactive elements makes such effects more prominent. Moreover, such interactive function can not only be applied among high achievement students, but achieve better effects among low achievement students.

5 Conclusions

This study introduces e-books into health care education and discusses the influence of e-books with different presentation modes on the learning effect of high and low achievement students. Based on the whole experiment, we can find that after the e-book teaching, whether the control group or the empirical group, the overall learning effect of students has been significantly improved. It can be seen that e-books are quite effective as a multimedia teaching carrier in health care education. Moreover, the addition of interactive elements also makes the learning effect of students better than those engaging in non-interactive elements.

According to the results of the study, there is no significant difference between the two groups of students before the study, representing that the degree of students is similar before the experiment. After the experiment, students show significant difference, representing that the interactive e-books are better than the non-interactive e-books in improving the learning effect. However, this result does not mean that non-interactive e-books are not a good teaching tool. Statistical results show that both groups have made significant progress in the learning effect, indicating the use of e-books for teaching has significantly promoted the learning effect of students, which is in line with the experimental results of many literature [7, 12, 15]. However, the addition of interactive elements allows students to make greater progress.

In the following statistics, it can also be found that e-books are a feasible way to reduce the gap between high and low achievement students. Such research results may effectively help to reduce the gap among students. In addition, the impact of interactive elements on low achievement students is greater than that of high achievement students, and the e-book teaching with interactive elements plays a greater role in promoting learning effect than general e-book teaching.

Acknowledgments. This work is partially supported by Ministry of Science and Technology, Taiwan under grant MOST 107-2511-H-224-004-MY3 and MOST 108-2628-H-224-001-MY3.

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Using an Augmented-Reality Board Game for Drug Addiction Prevention at a University in Taiwan

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Abstract. Recent years have witnessed serious drug abuse, which has caused numerous societal problems. Schools thus are incorporating anti-drug use into formal curricula. However, current anti-drug courses employ unidirectional or lecture-based approaches, which make anti-drug knowledge acquisition dull and unattractive, thus leading to ineffective outcomes. In order to improve learning effectiveness, this study designed an augmented-reality (AR) board game for university campus drug prevention. Thirty-nine undergraduates with an average age of 19 at an university in Tainan, Taiwan participated in the study. Results show that the AR board game on drug prevention can effectively enhance learning effectiveness. Interviews revealed positive perceptions on usability and joyful learning with the board game.

Keywords: Augmented Reality · Board game · Game-based learning · Prevention of drugs addiction

1 Introduction

Since 2001, curriculum implementation at primary and middle schools in Taiwan began to incorporate anti-drug use and drug prevention as part of physical education and well-being programs. The goal was to help learners become aware of the harms caused by drugs and resist against drug use [1]. Current anti-drug courses or campaigns still employ unidirectional or lecture-based teaching, making knowledge transmission about anti-drug use routine-based and dull. [2] thus suggested using techniques to relate the content of anti-drug promotion to students' lives or employ instructional strategies to make the learning more interesting. In addition, [3] claimed that traditional teaching styles might not effectively promote anti-drug awareness and drug addiction prevention. More creative teaching styles thus need to be developed.

Over the past twenty years, the application of AR technology has become increasingly popular [4]. The technology, both in terms of hardware and software, has become mature. Moreover, as Pokémon became a hit, the public has gained awareness about AR, and AR technology is now increasingly used in education, entertainment, tourism, medicine, shopping, and art. The wide application of AR has made

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 24–32, 2019.
https://doi.org/10.1007/978-3-030-35343-8_3

information transmission more multimodal and interesting, which also makes AR a research focus as a technology for creating innovative learning environments [5].

Learners often lack motivation and feel disinterested in learning situations with traditional instructional modes. Therefore, as AR technology emerged, educators begin to explore ways to motivate learners, including the use of games in learning. Game-based learning is an effective instructional approach, and helps enhance learning motivation and learning effectiveness. Compared to traditional learning methods, game-based learning can better attract children as they learn [6]. This study therefore incorporates game-based learning and AR technology into anti-drug promotion and instruction in order to overcome the limitations with traditional lecture-based teaching in drug prevention programs.

Previous research has shown that board games can be applied in teaching procedures to enhance instructional outcomes. Many scholars also point out the positive facilitation effects of board games [7, 8]. By combining board games with game-based learning, learners can develop the ability to self-construct knowledge with more learning initiatives and motivation.

With the above rationale, this study designed a Campus Drug Prevention Augmented Reality Board Game to engage undergraduates in game-based learning. Through the combination of AR and mobile-based learning content, the campus anti-drug program at the target university can be evaluated for its effectiveness in helping undergraduates acquire drug prevention knowledge, as well as learners' perceptions of playing the board game.

The study aims to address the following research questions:

1. Can a Campus Drug Prevention Augmented-Reality Board Game lead to effective learning outcomes?
2. What are the learners' perceptions of a Campus Drug Prevention Augmented-Reality Board Game?

2 Literature Review

The researchers of this study developed a Campus Drug Prevention Augmented-Reality Board Game to facilitate learning. The literature review thus aims to introduce the following concepts augmented reality, board game, and game-based learning.

2.1 Augmented Reality

Augmented-reality combines the real world with virtual environments by overlaying virtual objects in real scenes. According to [9], along the reality-virtual continuum, real environment and virtual environments are found at two ends, and AR is located between real environment and the center of the continuum (See Fig. 1).

Augmented Reality (AR) has received higher overall evaluation in the potential and innovative application to education, medication, fine arts, amusement and recreation, as well as the training courses for medicine, military, disaster escape, manufacturing, etc. [10, 11] explored materials de-signed with AR on language learners' vocabulary

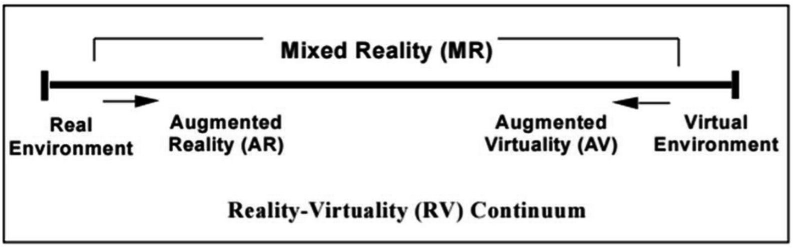

Fig. 1. Definition of augmented reality [9].

learning. The results suggested that AR technology increased students' motivation. [12] also discussed the influences of 2D Image-Based AR and VR on student learning. The results show that real objects presented in the AR system can reduce psychological load, enhance learning motivation, and encourage students to keep performing the tasks. [13] further found that AR technology use within a mathematics lesson increases student achievement and enhances student motivation to learn mathematics. The findings from the above-mentioned studies indicate that aside from connecting users to AR and VR content, AR and VR technology can enhance learner understanding, increase motivation, and bring forth learning joy and enthusiasm.

2.2 Board Game

Board games are games that feature regularities and are complemented with components such as cards, dice, chessmen, etc. They encompass all games that are executed with at least two players engaging in face-to-face play on a flat board. [14] developed a novel astronomy board game. Results indicate that this astronomy board game significantly enhanced students' learning outcomes related to astronomy concepts and scientific reasoning. [15] claimed that board games provide real experience, enhances motivation, and activates higher-order thinking. [16] used an anti-tobacco educational board game to help learners gain perceived knowledge and increase negative attitudes toward tobacco company tactics which encouraged smoking.

In summary, the effects of board games have been approved to be positive. This motivated the researchers of this study to employ a board game to achieve teaching goals, enhance learning motivation, and improve learning outcomes.

2.3 Game-Based Learning

Game-based learning refers to learning through playing games. As learners encounter problems or challenge levels, they must use their knowledge to overcome the obstacles, and acquire target knowledge, thus achieving learning goals.

[17] used a mobile game-based English vocabulary practice system to improve English learning motivation and interest. Investigation results indicate that students who used the proposed system exhibited higher learning interest, attention, and learning effectiveness, as well as a sense of accomplishment and triumph. [18] also

suggested that game engagement has a positive effect on learning. [19] view that game-based learning might be superior to traditional classroom instruction as it could increase students' motivation for learning and provide them with opportunities to explore and acquire new knowledge and skills.

3 Research Methods

This section introduces the research design based on the literature review above. The method includes an evaluation questionnaire after the board game and interviews. The purpose of the survey and interviews was to understand the learning process among learners, as well as their knowledge level concerning drug prevention after playing the board game.

3.1 Research Process

This study aims to investigate the effect of incorporating an AR board game into campus drug prevention. The participants are divided into small groups, with a mobile device and game board allocated for each group. The experiment ran for 90 min. Prior to the experiment, a ten-minute pre-test was given to the participants, followed by a ten-minute introduction session on how to play the board game on drug prevention. After the introduction session, participants played for fifty minutes. Then, a ten-minute post-test took place. A twenty-minute focus group discussion was conducted after the post-test. Figure 2 presents the research process in a flowchart.

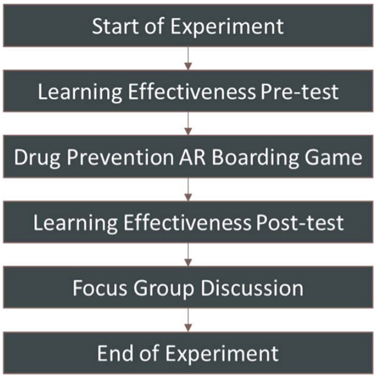

Fig. 2. The research process flowchart.

3.2 Subjects

The participants of the study were undergraduates at a university located in southern Taiwan. The sample size was 39, and the ages ranged from 18 to 20, with an average age of 19. A total of ten groups were formed, with three to four people in each group.

3.3 Research Tool

This research uses pre-/post-tests as instruments, as described below:

Pre-and Post- Learning Performance Scale. The research adopts the pre-/post-test assessment method to evaluate users' learning effectiveness based on the board game intervention. The test, which focused on knowledge related to drug prevention and overuse, was adopted from the Ministry of Education. The purpose was to measure the extent to which learners acquired knowledge about drug prevention after the board game intervention, and to see the effectiveness of the AR board game for helping students prevent drug addiction. The data were quantified with 25 items, 10 of which were Yes/No questions, and 15 of which were multiple choice questions.

3.4 Design Principles of the Board Game

In the curriculum for drug prevention, the use of the AR board game involved steps such as competition for answering questions about drug prevention topics. Through the playing process, learner motivation can be increased due to a novel approach to teaching and learning.

3.5 Board Game Components

See Fig. 3 and Table 1.

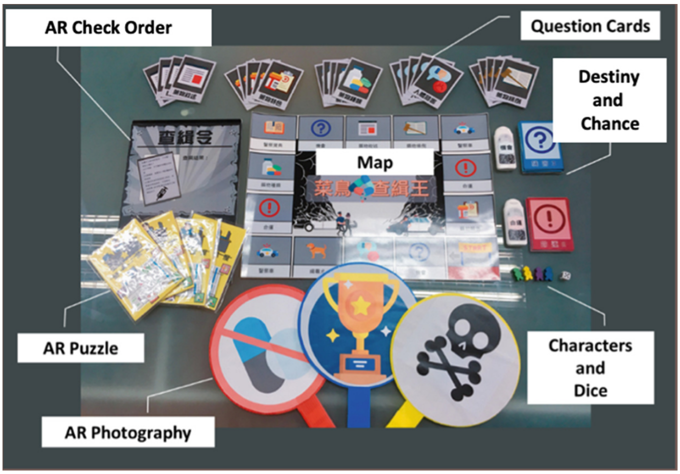

Fig. 3. The augmented-reality drug prevention board game.

3.6 Game Rules

Four people formed a group, and decided the game order as well as the color of the character via Paper-Scissor-Stone. Then, they placed AR Puzzle beside the game board, and moved by rolling the dice. If they encountered Chance or Destiny along the path,

Table 1. Components of augmented-reality board game for drug prevention.

Game component	Component explanation
AR check order	Place the question on Check Order and scan the Check Order with the mobile device. The results and information related to the Check Order will then appear
AR puzzle	If the player collects cards from 9 different districts, and places the card on the District where each card belongs for mobile device to scan on the map, then the instruction for the next step will appear
AR photography	The winner can take an AR photograph of the Trophy by scanning the card with the mobile device. Other players can also do the same with their cards
Question cards	The 25 question cards are based on a drug misuse questionnaire from the Ministry of Education, which includes drug descriptions, drug types, drug characteristics, drug-related legal terms, and harms on the human body
Destiny and chance	If the Destiny Card was drawn, the event on the card will occur immediately. If the Chance Card was selected, the player can either have it occur right away or keep it as a card on hand (each person can have up to 4 cards on hand). If all of the Destiny and Chance cards have been picked, then the player needs to draw cards again
Characters and dice	The characters in the game represent the players. The dice are for determining how steps the player can move forward

they opened the Drug Bottle to draw for a number or alphabet. The number or alphabet would then match to a Chance or Destiny Card. The Destiny Card allows the player to immediately actualize the event, while the Chance Card allows the player to immediately actualize the event or keep the card on hand. A player can keep up to four cards on hand, and if the cards are used up, the player has to start over with the Drug Bottle draw again. If the player goes to a district to pick a Question Card, and answer the question, he or she can then check their answer with the AR Check Order. If the answer is correct, the player can get a puzzle piece. If the answer is incorrect, then the player needs to take a rest at the Police Station. The players need to collect all the AR puzzle pieces in the five districts and finish the AR Puzzle. They can then scan the finished puzzle and check what to do next. The final winner needs to answer five Question Cards (one from each district) correctly by random draw in order to announce final victory in the game. The player can use different strategies (Use Chance Cards to prevent other players from winning or to increase own ad-vantage) to reach victory. The actual playing scene is shown in Fig. 4.

Fig. 4. Learners playing the AR board game for campus drug prevention.

4 Results

4.1 Evaluation of Learning Effectiveness

This sub-section mainly discusses the learning effectiveness of using the AR board game for campus drug prevention. Comparison on the familiarity with drug prevention before and after board game playing led to analysis on changes in knowledge levels. Table 2 presents results of paired-samples t-test, which show significant improvement of learners' drug prevention knowledge after the game board intervention ($t(38) = -10.837$, $p = .000$, $d = 2.19$). Post-test learning outcomes were significantly better than those of pre-test. The statistical results reveal the effectiveness of using the AR board game to enhance learning outcomes about campus drug prevention.

Table 2. Evaluation of learning effectiveness.

Dimension	Mean (*SD*)		*df*	*t*	*p*	d
	Pre-test	Post-test				
Score	57.74 (14.84)	85.44(9.86)	38	−10.837	.000	2.19

4.2 Focus Group Results

The focus group discussion after the experiment was recorded and turned into the transcript with highlighted key points for open coding in Grounded Theory [20].

Through the coding process, the researchers identified the usability, expected outcomes, and intention to use among learners. The codes were organized into the themes below:

Board Game Usability: The AR board game for drug prevention was easy to operate. Not only did it enhance knowledge and awareness of drug prevention, but also it combined knowledge transmission with AR as a novelty. The instruction was joyful and revealed good usability.

Self-Evaluation: The participants expressed that they understood the game rules well and acquired relevant knowledge. They further thought that they performed well and had positive attitude throughout the game-based learning process.

Intention/Willingness to Use: The participants expressed willingness to promote the board game so that more people could experience the game-based learning, reflecting a high acceptance of the AR board game.

Expected Outcome: The participants indicated that the AR board game for drug prevention was very interesting and meaningful as an educational tool. They expected to see more questions and mechanisms to enrich the design of the board game.

5 Conclusion

To improve drug prevention programs and course instruction by avoiding unidirectional and lecture-based teaching, this study combined AR technology with a board game in order to make drug prevention instruction more interesting and attractive. The researchers investigated the effectiveness of the AR board game on learning about drug prevention, and further evaluated users' perceptions with the game-based learning. The findings showed that learners' drug prevention knowledge improved significantly, thus implying that the AR board game was effective for learning. Moreover, the interview results reflected positive perceptions on the usability of the board game, the joyful learning enabled by the board game, and revealed intention/willingness to share the game to more people for promoting drug prevention.

In the future, aside from refining the board game quality, the researchers will al-so provide the AR game board to high schools and universities for drug prevention course planning, as it is expected that more students will benefit from board game learning. Furthermore, future research should explore the effects of board games on motivation, learning flow, game acceptance, or analyze learning behaviors during board game playing in order to better understand participants' learning processes. Future studies could also incorporate control groups to examine the effects of board game learning in detail.

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The Impact of Game-Based Situated Learning System in Oral Health Education

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Abstract. This study aimed to determine the effectiveness of a game-based situated learning system in oral health education, on middle age and elderly subjects. The learning outcomes of the middle-aged and elderly subjects were measured using an ARCS motivation scale and system usability scale, and by an experimental teaching mobile device. The subjects investigated in this study are all residents of Taichung City, who are aged 45 to 65 years, 15 males and 15 females were enrolled. There were three main results in our research: (1) Most of the middle age and elderly subjects have a positive experience in the use of the game-based situated learning system; (2) Compared to before use of the game-based situated learning system, the middle age and elderly subjects have significantly higher learning outcomes after the use of the system. (3) Compared to before using the game-based situated learning system, the middle age and elderly subjects have significantly higher motivation to learn after the use of the system. To conclude, this study found that a game-based situated learning system can improve the motivation and willingness of middle age and elderly subjects to learn oral health knowledge. In addition, the use of a game-based situated learning system may improve the oral health knowledge of middle age and elderly subjects, and have a positive impact on the behavior of oral health care in these subjects.

Keywords: Learning effect · Game-based learning · Oral health education · Situation learning

1 Introduction

With the development of the conception of public health, the improvement of living environment, and the advancement of health care technology, life of human is lengthening year by year. The [2] indicated that population aging around the world is related to the advancement of health care and economic growth, which made the expectation of life lengthen. The [1] indicated that the risk of having cavities of the middle age and elderly was higher than that of the elderly. In order to improve the preservation of teeth of the middle age and elderly, the public should possess appropriate knowledge of oral health, and change their attitude toward dentistry [3].

Knowledge is generated through an interaction between learner and situation, and influenced by society, activity, and context essentially [4]. If learner could play a virtual

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 33–40, 2019.
https://doi.org/10.1007/978-3-030-35343-8_4

role in the virtual environment of security and controllability, which provided the experience of “reality” and increased situation of presence, it could be considered as a means of providing an “authentic situation” for situated learning method [5]. For learner, situational simulation was regarded as a learning method with high efficiency [6].

Through games, people not only derive amusement but also learn, thus enhanced the development of cognition, affection, skill, and interpersonal relationship [18]. Game-based learning closely connected learning content and digital games to increase learner’s learning interest and motivation [7]. The [8] proposed that learner could be free from bondage to the real world in the context of games, and gain learning experience. Therefore, this study explored the learning motivation and learning effectiveness of middle age and elderly subjects after using the game-based situated learning system in oral health education.

2 Literature Review

Periodontal disease and dental caries are the two kinds of most common dental disease. Both of the final results of them are exuviation. Therefore, the number of teeth is the representation of a person’s oral health status [9]. The [10] indicated that the more missing teeth and the fewer remaining teeth, the more intensity and meaning to senior ethnic group. Oral health of the elderly is their primary demand. However, as the growth of the age, the weak body, and the difficulty of moving, oral health of the elderly would become more and more neglected. It is worth noting that education can improve oral health knowledge, oral self-care practices and oral examination results. [11]. The [20] indicated that there was a negative correlation between sweets intake amount and preventive behavior and self-efficacy of oral hygiene. The more sweets the participants took in, the less self-efficacy and the worse behavior of oral hygiene they had. The [19] divided the elderly into four groups, which were experimental group of community residents, control group of community residents, experimental group of long-term care institutions, control group of long-term care institutions. After experimental group of community residents and experimental group of long-term care institutions accepted oral health education for 12 weeks, the status of their oral hygiene had improved apparently.

The theory of situated learning originated from the learning concept of “knowing in action” and “reflection in action” that proposed by the [12]. The [4] presented a paper of situated cognition and culture of learning, which emphasized that knowledge is generated through an interaction between learner and situation, and influenced by society, activity, and context essentially. Learner could learn though real or simulated situation to have an effectively learning. That is to say, only if knowledge was explained in the situation where it generated and applied, would it create meaning [21]. The [23] improved traditional medical care, applying virtual reality (VR), augmented reality (AR), and mixed reality (MR) to simulated surgery. It not only had no risk, but also made interns and residents who had less experience learn from mistakes. They could realize potential danger in operating environment, and improve effectiveness learning through constant practice.

Games play an important role and possess critical functions in human life. Through games, people not only derive amusement but also learn, thus enhanced the development of cognition, affection, skill, and interpersonal relationship [18]. Games is a kind of intrinsic motivation from children's heart, which is free, voluntary, and unrestrained. There were no better leaning methods than games. Innate behavior mode let him understand the surroundings and begin self-learning. Game-based learning must make learner consider the learning content interesting and attractive [13, 14]. The [15] divided the schoolchildren into experimental group (n = 29) and control group (n = 21). Compare game-based e-learning with common computer-assisted instruction, it was found that game-based e-learning effectively helped increase student's ability of cognitive learning and solving problems by themselves. The [16] used Delphi method on 57 participants to analyze the effect of game-based learning system on nursing course. The participants said that the game had attracted students and increased attention. If it could add simulated situation learning, it would be more complete.

3 Research Method

This study mainly explored the difference of learning effectiveness, acceptance of learning system, and learning motivation of the middle age and elderly in the oral hygiene course after the subjects used different learning methods. It used one-group pretest-posttest design of pre-experimental design. Before the experiment, the pretest of oral hygiene knowledge learning and ARCS motivation scale were taken. During the experiment, the instruction on the situated oral hygiene learning system was conducted. After the experiment, the posttest of oral hygiene knowledge learning, system usability scale, and ARCS motivation scale were taken.

The situated oral hygiene learning system of this study used the applications in App Store, which were Little Panda's Toothbrush and Happy Teeth. The situated oral hygiene learning system was used through tablets by learners. The system is divided into three parts. Figure 1 below is the main menu in the system.

Fig. 1. Picture of the main menu in the system

1. Animation tutoring of oral care (Fig. 2), the function could be divided into: Situated tutoring of brushing teeth: Situated animation tutoring of this system not only teaches learner how to use Bayesian brushing, but also attract their attraction. Teaching subjects to brush their teeth for 2 min could cultivate them to concentrate on one thing.

Fig. 2. Picture of animation tutoring of oral care

2. Game of oral care (Fig. 3), the function could be divided into: Experience the process of brushing teeth: The game of oral care in this system, which starts from picking beautiful brushes and ends with having a gargle, makes learner realize that although the process is normal, it is a part of daily life and a key factor of maintaining oral health. Challenge to the game: In the game of oral care in this system, when clearing the oral bacteria, the bacteria would keep growing. It demands careful observation to achieve the cleaning effect, and is beneficial to learner's precision of cleaning teeth.

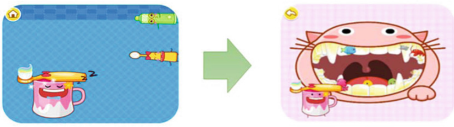

Fig. 3. Picture of the game of oral care

3. Situated game of dentist repairing (Fig. 4), the function could be divided into: Knowing and using dental instruments: Let learner be acquainted with the dental instruments and its functions. Using the instruments in the situated game of dentist repairing in this system makes learner not resist the periodical inspection of oral health. Dentist role play: In the situated game of dentist repairing in this system, learner could play a role of a dentist. From the perspective of a dentist, they could realize the importance of oral health.

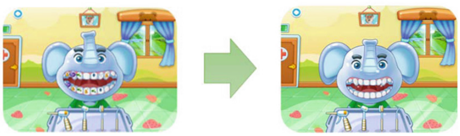

Fig. 4. Picture of the situated game of dentist repairing

In order to realize user's subjective feelings after operating this system, this study used system usability scale (SUS), which was proposed by Brooke in 1996, to evaluate user's usability in the system. This scale was designed based on 5-point Likert scale with 10 questions in total. Question number 1, 3, 5, 7, 9 were negatively worded questions, and question number 2, 4, 6, 8, 10 were positively worded questions. Selection 1 to 5 respectively represented strongly disagree, disagree, neutral, agree, and strongly agree. Since the scoring method of positively worded questions and negatively worded questions were different, the score of SUS would be within the range of 0 to 100 points. The higher the score, the more easily for users to interact with the system.

This study used the test papers in schoolchildren oral healthcare program of K-12 Education Administration, Ministry of Education, and divided the same types of the questions into pretest and posttest. In order to realize learner's learning motivation after using situated oral hygiene learning system, this study used ARCS model of motivation that proposed by Keller in 1999. The scale adapted the ARCS motivation scale that designed by Lin [24] and Yen [25] to revise. There were 16 questions in the scale with four dimensions of attention, relevance, confidence, and satisfaction. It was designed according to 5-point Likert scale, in which selection 1 to 5 respectively represented strongly disagree, disagree, neutral, agree, and strongly agree. The higher the total score, the more positive the motivation after using situated oral hygiene learning system.

The subjects of this study were the middle age and elderly in an area of Taichung, using one-group pretest-posttest design of pre-experimental design to conduct oral healthcare tutoring. Before the experiment, the pretest lasted for 30 min to fill out ARCS motivation scale and the pretest of oral healthcare learning. The experiment lasted for 60 min to operate the situated oral hygiene learning system. After the experiment, the posttest lasted for 30 min to fill out ARCS motivation scale, system usability scale, and the posttest of oral healthcare learning.

4 Experimental Analysis and Results

4.1 Analysis of Learning Effect

This section mainly analyzed the difference of learning effectiveness between before and after subjects using the situated oral hygiene learning system by using Paired Sample t test. It could be seen in Table 1 that the average score before using the system was 69.33, the standard deviation was 28.16, and the average score after using the system was 84.67, the standard deviation was 17.65. The score after using the system was 15.34 higher than that before using the system. In terms of the average score, subject's learning effectiveness of after using the situated oral hygiene learning system was significantly higher than that of before using the system. Therefore, the situated oral hygiene learning system was beneficial to oral hygiene learning for subjects.

Table 1. Learning effectiveness of the score of pretest and posttest of the middle age and elderly *t*-test.

Test	*N*	*Mean*	*S.D.*	*t*
Pre-test	30	69.33	28.16	-3.29^{*}
Post-test	30	84.67	17.65	

$^{*}p < 0.05$

4.2 Analysis of Learning Motivation

The subjects of this study took the ARCS motivation scale before and after the test, the result was as shown in Table 2. The average score of the dimension of attention slightly increased from 14.93 to 16.6. The score after using the system was 1.63 higher than that before using the system. The average score of the dimension of relevance increased from 8.33 to 16.4. The score after using the system was 8.07 higher than that before using the system. The average score of the dimension of confidence increased from 8.23 to 16.43. The score after using the system was 8.2 higher than that before using the system. The average score of the dimension of satisfaction increased from 7.93 to 16.27. The score after using the system was 8.26 higher than that before using the system. Overall average score of motivation increased from 39.47 to 65.76. The score after using the system was 26.29 higher than that before using the system. Therefore, the situated oral hygiene learning system helped increase subject's motivation for oral hygiene learning.

Table 2. The score of pretest and posttest of ARCS motivation scale.

Dimension	Test	*Mean*	*S.D.*	*t*
Attention	Pre-test	14.97	1.30	-24.05^{**}
	Post-test	16.6	1.65	
Relevance	Pre-test	8.33	1.47	-22.47^{**}
	Post-test	16.4	1.67	
Confidence	Pre-test	8.23	1.36	-22.38^{**}
	Post-test	16.43	1.63	
Satisfaction	Pre-test	7.93	1.36	-19.16^{**}
	Post-test	16.27	1.96	
Overall	Pre-test	39.47	2.84	-24.05^{**}
	Post-test	65.76	5.65	

$^{**}p < 0.01$

5 Conclusions

Assessed by the system usability scale (SUS) that proposed by the [22], the average score of the middle age and elderly using the situated oral hygiene learning system was 71.1. Therefore, it showed that the middle age and elderly clearly understood the teaching content of the situated oral hygiene learning system and the purpose of game-based learning.

The average score of the test that conducted before the middle age and elderly used the situated oral hygiene learning system was 69.33, while the average score of the test that conducted after the middle age and elderly used the situated oral hygiene learning system was 84.67. It demonstrated that the situated oral hygiene learning system was helpful for the middle age and elderly to learn oral hygiene. Levin-Banchik [17] simulated the learning effectiveness of situated learning, which was more effective than other teaching models. Therefore, it could be explained that the middle age and elderly using the situated oral hygiene learning system helped improve their knowledge of hygiene education.

The ensemble average of ARCS motivation scale before the middle age and elderly used the situated oral hygiene learning system was 39.47, while the ensemble average of ARCS motivation scale after the middle age and elderly used the situated oral hygiene learning system was 65.47. It demonstrated that the situated oral hygiene learning system was helpful for the middle age and elderly to improve their learning motivation. Chang et al. [7] indicated that game-based learning was to connect learning content and video games closely to increase learner's learning interest, which was in conformity with the result of this study. Therefore, it could be explained that the middle age and elderly used the situated oral hygiene learning system to stimulate motivation by games.

This study merely researched on the subjects of the middle age and elderly in Taichung City. It is suggested to expand the selection of samples in the follow-up research, taking the middle age and elderly of different areas as subjects to conduct teaching experiment and exploring the applicability of the research model. This study merely researched on oral health education. It is suggested to use plaque disclosing tablets to observe the difference between before and after the experiment of subjects brushing teeth to explore the correctness of brushing method.

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The Application of Augmented Reality to the Education of Chemistry – Take the Course of Nature Science in Junior High School as an Example

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Abstract. In the modern society featuring developed information technology, the integration of technology into various aspects of life has been normal. Studies regarding the integration of technology into educational scenarios have also flourished. This study will integrate the augmented reality (AR) technology into the teaching of natural science for the eighth grade of middle school. This technology assists learners in learning about chemical units, such as “mole number”, “atomic weight” and “molecular weight”, to understand the composition and characteristics of matter. The concepts of this unit are relatively abstract, so the characteristics of AR combined with learners’ life experience can present the world of microscopic particles, which are invisible to the naked eye and complex and abstract, enabling learners to establish correct rules and imagine the microscopic particle world properly and paving a smooth way for future chemistry learning.

Keywords: Augmented Reality · Chemistry education · Moles · Nature science

1 Introduction

In an era of booming digital technology, the application of digital technology to learning is also accelerating. Information technology is used widely in life, where artificial intelligence, Internet and timely interactive live broadcast are permeating. It is not uncommon to see the application of information technology to education. Many studies are now exploring the integration of information into education, such as the application of information technology to medical teaching or training scenarios [1], the application of artificial intelligence robots to language learning [2]. There are even cases in which information technology is used in the teaching environment to analyze or predict students’ learning outcomes [3]. How to combine these information

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 41–48, 2019.
https://doi.org/10.1007/978-3-030-35343-8_5

technologies into education and improve the efficiency and effectiveness of learning is an important topic.

The subject of this study is the teaching of natural science, physics and chemistry, which is part of the curriculum in the second year of middle schools in Taiwan. The concepts of the subjects are mostly abstract and learners need to understand scientific phenomena or principles invisible to the naked eye. Although creative and complicated imagination is widely required in the Subject, many examples are actually phenomena that will be experienced in real life, so the understanding of these principles remains important to students.

When learning the Subject, many students may encounter elements that hinder their imagination or learning. As a result, their learning outcomes decline, preventing them from being able to achieve the scheduled goals and even reducing their willingness to learn this subject. Therefore, this study intends to assist students in better imagination by integrating information technology into teaching, so that more learners will be interested in the Subject and achieve their learning goals.

This study intends to integrate the information technology of AR into the Subject. This study is scheduled to select one of learning units of the Subject for the second semester of the eighth grade, namely atomic weight, molecular weight and mole number.

The learning goals of this unit is to understand the meaning of "atomic weight", "molecular weight" and "mole number" and to learn how to calculate their respective transformations. In this unit, what "atomic weight", "molecular weight" and "mole number" mean will serve as the basis for the following learning unit - chemical equations and stoichiometry. Learners will enter the world of microscopic particles that is invisible to the naked eye, so how to guide learners to properly imagine and establish correct basic concepts will be one of the important goals.

This research intends to present the microscopic particle world that is invisible to learners through AR technology, enabling learners to correctly imagine and establish the basic rules of the microscopic particle world.

2 Literature Review

2.1 Augmented Reality (AR)

AR is an information technology that can present virtual objects or digital information in the real world. AR can also be regarded as a bridge between the real world and the virtual digital one [4]. Reality-virtuality continuum [5] (see Fig. 1) is used to describe the relationship between the real world and the virtual one. The real world is where users live. Virtual reality is to provide users with a completely virtual world. The mixed reality is to integrate the virtual world with the real one so that users can interact with objects in the environment and receive feedback from such objects [6]. These three worlds are interconnected by AR, through which virtual objects can be presented in the real world and real objects can be presented in the virtual world. Therefore, it is not overstating that AR is the key technology that connects everything.

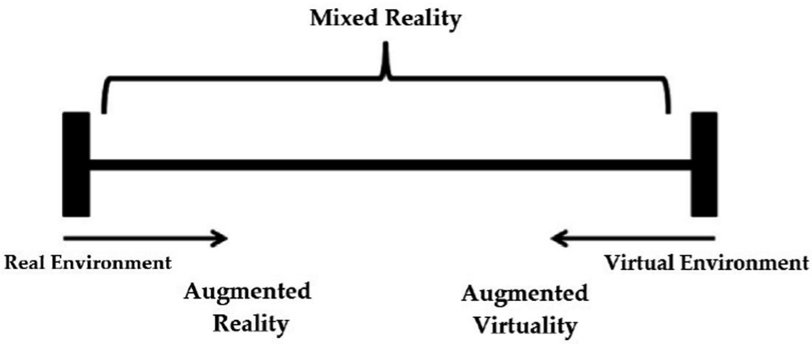

Fig. 1. Reality-virtuality continuum.

2.2 Current Situation of AR

In recent years, AR has been used in many different fields. For example, the well-known mobile game "Pokemon GO" is a successful case of AR in daily life. In fact, "Pokemon GO" is definitely not the only card game combined with AR. Applying AR to games can explore many possibilities including the interaction between users and games. Scholars are even studying whether such combination can increase users' willingness to do outdoor exercise [7].

AR has also been applied to many other fields, such as the AR-guided visit in museums or exhibitions, through which the visit can be more informative for viewers. In addition, AR as a digital resource can convey relevant information or links to viewers more easily online. The more abundant interactive information provides viewers with more to learn in the museum [8]. Besides, whether AR can raise the value of museum visits is also a popular research topic.

2.3 Application of AR to Education

The application of AR is very extensive, and the examples of its application to education are numerous. For example, subjects of medical care involve many parts invisible to naked eyes, such as internal organs and tiny organizations. AR makes it easier for students to observe and assists them in simulating the training of operation [9].

In addition to subjects of medical care, AR is also widely applied to subjects of natural science. In the case of biology, the distribution of different animals or the limited observation of human eyes exerts difficulty on the observation of many living things or phenomena, but AR is making such observations easier [10].

This research is also aimed at natural science. It intends to assist students in imagining what the microscopic particle world is by integrating AR into teaching, and help learners establish the correct basic chemical rules to achieve their learning objectives.

2.4 Motives and Advantages of Applying AR to Natural Science Teaching

This study integrates AR into the teaching of the natural science. The motive for such integration is explained as follows. The education of natural science is to describe the phenomena occurring in the real world or to expound the principle of such phenomena. Therefore, the best way to learn each unit would be the presentation of what a phenomenon or reaction is to learners. However, given that there is no way to copy and present all the reactions and phenomena for learners in classroom, it is pointed out that imagination is important to learning [11]. If learners fail to have correct imagination, it will also cause obstacles for subsequent learning. Considering the above, this study intends to leverage information technologies to present learners these reactions and phenomena as genuinely as possible, helping learners complete their learning goals.

In addition, compared with the traditional teaching mode featuring one-way transfer of knowledge, the integration of information technology into teaching materials and the consequently intense interaction with learners can also stimulate learners' motivation for learning and achieve learning objectives [12].

Due to certain characteristics of the real space, the reaction cannot be reproduced smoothly. For example: (1) The materials required for the experiment are not easy to obtain or expensive; (2) If a small change and repeated demand occur in experiment, the cost of material or time required for the change is excessively high; (3) The physical experiment process is relatively fixed and cannot be flexibly adjusted or changed according to the different conditions of each learner.

In contrast, such difficulty that is more likely to be encountered in real space can be overcame at a lower cost in virtual space. (1) Since information can be presented in virtual space by simulation, the scarce access to certain materials is no more a problem; (2) Likewise, the virtual space is cost- and time-saving for material changes; (3) Information technology facilitates the customization of textbooks or teaching content for each learner, who can adjust the pace according to his or her own learning progress and complete the learning objectives given by the teacher.

3 Research Method

3.1 Introduction of the System

Name of system: Mr. Mole

The objective of this study is to design a set of AR system. This system will be used for the course planning and systematic design of "Composition and Characteristics of Materials", one of the themes of the subject taught in the eighth grade of middle schools in Taiwan.

The system developed by this study is expected to be used along with textbooks. This system will provide more concrete and highly interactive content for textbooks, allowing users to combine what they learn with their life experience and understand their learning objectives better.

3.2 Research Subjects

1. The subject of the study is the eighth-grade students of middle schools.
2. This study is the first time for to learn about teaching units regarding stoichiometric. Before learning this unit, they only have knowledge of the names of chemical elements, and have not yet studied the calculation of chemical equations and chemical reactions.

3.3 Learning Objects

According to the content of the learning unit—the composition and characteristics of matter, learners need to understand what "mole", "atomic weight" and "molecular weight", learn the correlation between the three, and know how to calculate for the conversion between the three, enabling them to establish the basic rules for the microparticle world.

3.4 Model of the System

The process of this system will be divided into three stages. After the teaching of each stage is completed, a test will be conducted to allow users to check how far they have gone in achieving learning objectives, and provide users with feedback for their mistakes and reward points for their merits.

1. The first stage
   The first stage of the system is to connect the dots. At this stage, the teaching of this unit has not yet focused on the key, namely the "mole", "atomic weight" and "molecular weight". Instead, concepts such as "bead", "bag" and "weight" are introduced. By placing the beads in various bags and measuring their respective weight, users are guided to integrate their experience of life into learning, deepening their impression on these concepts (see Fig. 2).

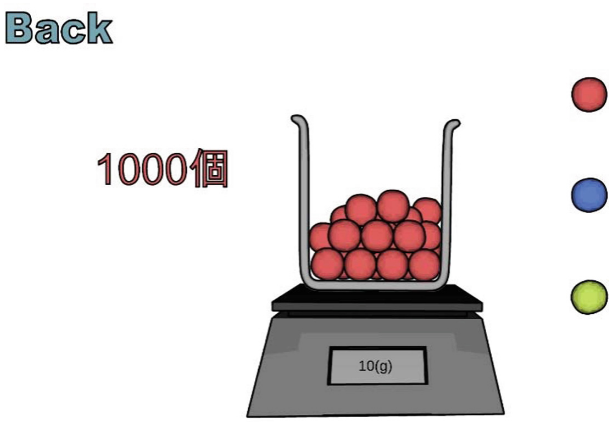

Fig. 2. Using screenshot of the first stage.

2. The second stage
   After the end of the first stage, the second stage begins where the teaching focus will be introduced, namely the meaning of "mole" and "atomic weight". The contents taught in the first stage and the second stage will be linked, allowing users to connect the "beads" of the first stage with the "various types of atoms" of the second stage, the concept of "bag" of the first stage is connected with the "mole" of the second stage. Users are guided to learn the meaning of these terms that they just know by using the impressions having occurred in the first stage, and to know the relationship among them and their calculation (see Fig. 3).

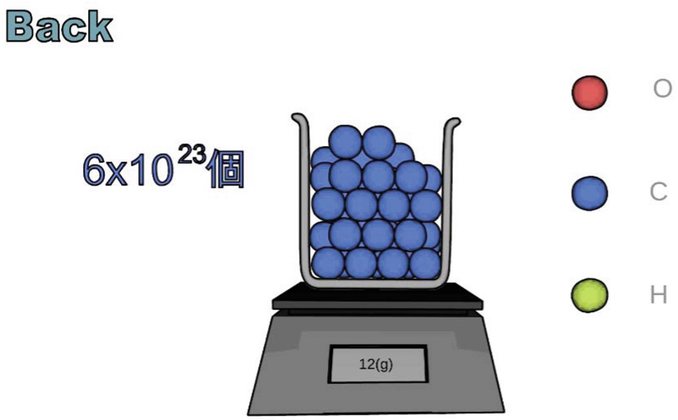

Fig. 3. Using screenshot of the second stage.

3. The third stage
   Finally, we will enter the third stage of the system, namely the advanced knowledge of the second stage. After the learning and practice of the second stage, users have understood what "mole" and "atomic weight" are. As a result, what "molecular weight" means will be introduced in the third stage and its relation with "mole" and how it is calculated will be understood. In addition, after the learning of the third stage, users will understand the difference and relationship between "atomic weight" and "molecular weight" (see 錯誤! 找不到參照來源。) (Fig. 4).

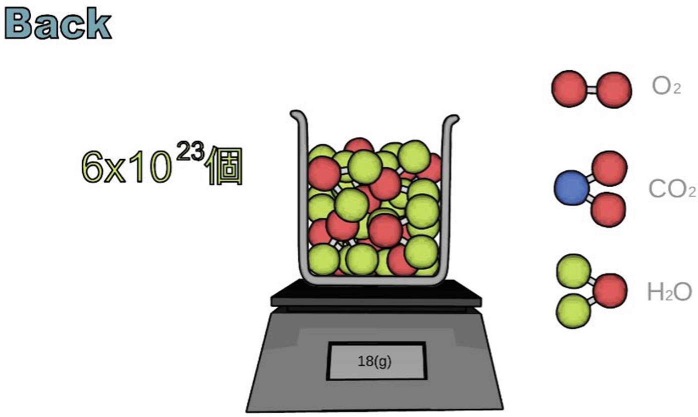

Fig. 4. Using screenshot of the third stage.

3.5 Conclusion

This study is to introduce AR information technology to natural science education by using it in the subject of chemistry. Compared with other units of the subject, the target learning unit of this study is a description of the phenomena in the microscopic world; many concepts of this unit are new to users. The failure to have a correct imagination is one of the problems that learners often encounter. Besides, the principles learned in this unit lay the foundation for the subsequent calculation of relevant chemical equations. The failure to imagine and use the skills and content learned in this unit will impose obstacles on the subsequent learning of chemistry- or computing-related subjects.

This study intends to use the AR technology combined with the previous life experience of learners to guide the learners to imagine properly step by step, and lay a solid foundation for the correct perception of microscopic particle world by learners.

3.6 Suggestion

This study is expected to use the AR system for the future teaching of natural science in middle schools. This study will observe students in the teaching process and collect the test scores and satisfaction-related questionnaires after they complete the learning unit, and analyze the data to see whether the AR system contributes to learning and imagination in natural science education. This study will also compare the application of the AR system with the traditional teaching methods to see whether the system exerts a significant impact on students receiving natural science education.

In addition, the subject of this study is middle school students, who are learning or absorbing new information rapidly. Given the subject of this study, how to properly use AR technology to assist students in learning natural science and grasping the learning objectives should be a major focus of this study, lest the system become a tool for pure entertainment.

Acknowledgments. This work is partially supported by Ministry of Science and Technology, Taiwan under grant MOST 107-2511-H-224-004-MY3 and MOST 108-2628-H-224-001-MY3.

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A Study of Problem Solving Using Blocks Vehicle in a STEAM Course for Lower Elementary Levels

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Abstract. STEAM education is currently one of the most important parts of the elementary school curriculum. If STEAM learning can cultivate good problem-solving ability, it will also help improve judgment and thinking abilities. Several voices in the literature have argued for cooperative learning in STEAM courses. Although the effectiveness of course learning often is evaluated using course feedback forms, there is comparatively little emphasis on whether a course succeeds in realizing cooperative learning. For a course involving self-propelled toy-brick cars, there is little research on the application of low-grade pupils. Therefore, based on the integration of STEAM courses into self-propelled toy-brick car learning, this study applied two learning strategies of cooperative learning and individual learning to low-grade pupils in the second grade in elementary schools. After completing the course problem-solving ability indicators were measured and analyzed using the problem-solving ability test. The results show that the mean score of the experimental group in the problem-solving ability test was higher than that of the control group. In the problem-solving ability test, the scores of the two groups were also significantly different, which suggests that cooperative learning is more effective than individual learning strategies.

Keywords: STEAM · Problem solving · Self-propelled car · Cooperative learning

1 Introduction

The 21st century is an era of rapid change and development, also known as an era of knowledge economy. In order to enhance the competitiveness of the country, talent cultivation is currently one of the topics that many countries attach great importance to. In 2009, US President Barack Obama launched the training of 100,000 STEAM teachers in the "10-Year Plan for Educational Innovation" policy [1]. STEAM

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 49–57, 2019.
https://doi.org/10.1007/978-3-030-35343-8_6

education is now the key to cultivating scientifically and technologically innovative talents in the United States [2]. In addition, in the process of educational reform, pupils' creativity and practical ability are cultivated. Influenced by STEAM education in the United States and facing the pressure of intensifying global competition in science and technology, countries around the world have begun to actively promote STEAM education [3]. The importance of STEAM courses includes: starting from problems or situations, combining with real life situations, the programs and problem-solving abilities acquired by pupils can also be applied to the same or different situations in life [4]. It focuses on the learning process, and in addition to knowledge transfer, hands-on implementation and innovative thinking, the more important thing is the in-depth participation in the learning process and the enhancement of learning interest [5].

This study explored lower-grade elementary school pupils' problem-solving abilities when carrying out experiments after being subjected to STEAM courses making use of either cooperative learning or individual learning. We designed and planned cross-disciplinary STEAM courses and used self-propelled toy-brick cars to stimulate pupils to work independently. The content is related to life, thus arousing the curiosity to explore and apply knowledge in real-life. Pupils are thereby freer to explore, to learn, and to connect to real-life problems. Besides acquiring professional knowledge, pupils also learn skills in different fields that hopefully strengthen the perceived importance of science and technology. Pupils also learn teamwork, learn to be responsible for their own behaviors and cultivate professional attitudes and behaviors [6].

This study applied cross-disciplinary STEAM course teaching to two classes of second grade elementary school pupils to explore the effect of cooperative learning in contrast to individual learning on the effectiveness of their problem-solving abilities.

2 Related Work

2.1 STEAM Courses

STEAM courses integrate science, technology, engineering, mathematics, art, and other interdisciplinary courses [7]. It is a teaching method that emphasizes interdisciplinary cooperation. The purpose of STEAM education is to design and explore, and to solve problems using scientific and technological thinking. The design of course content, activities, and evaluation can be linked with the current development of science and technology or relevant experiences in real-life [8]. In the process working practically with their hands and cultivating problem-solving abilities, pupils are enabled to understand the interrelationships between various disciplines. STEAM can be defined as the education of improving pupils' interest in and understanding of science and technology, and the education of improving STEAM literacy based on science and technology and the ability to solve real world problems [9]. With the emphasis on education of science and technology in the United States, many science education policies and corresponding programs have followed. STEAM course integration relies on cooperative learning, science and technology teaching, exploring and learning courses and multiple assessment methods [10] to cultivate pupils' ability to use group cooperation, learn team cooperation, good communication skills and problem-solving skills. STEAM course integration adheres to the concept of pupil-centered teaching, emphasizes the connection with real social situations, and improves pupils' interest in science and technology by the process of actively constructing knowledge and learning integrated scientific knowledge and skills [11, 12].

In the learning process of STEAM education, emphasis is placed on hands-on, problem-solving and scheme-inquiry-oriented teaching, which can cultivate children's comprehensive abilities both internally and externally, including inquiry ability, critical thinking ability, creative thinking ability and problem-solving ability. Therefore, STEAM education can cultivate children's patience, willpower and frustration tolerance, and learn to be responsible for themselves [13].

2.2 Problem-Solving Ability

A problem is usually understood as the difference between current reality and expected goal [14], while problem solving involves the periodic interaction between cognition and action. Problem solving activities include defining the current and goal states, assessing a person's resources, identifying additional resource needs, identifying, constraining, and exploring basic assumptions that affect reasoning. When proposing models for systematic and critical reasoning, Paul [15] asserts that a fundamental element of problem definition involves deciding which conceptual elements to consider and which conceptual elements to exclude. As problems become more complex and structurally unreasonable, they are defined by interweaving technology and background elements. Considering the transformation process at the system and task levels, the latter is more inclusive by learning from the field of organizational research [16]. On the contrary, situational elements refer to the environment contained in these technological elements, including social, cultural, political, legal, ecological and economic characteristics [17].

In one's growth and development, there will be "problems" everywhere, which need to be "solved" from time to time. If we consider the "abilities" needed to deal with various problems together, we actually include "all abilities". We try to extract "representatives" of the abilities needed to deal with problems from all abilities (it may be only a part of all abilities, and is given an integrated name), and declare such ability as "problem-solving ability" [18].

2.3 Cooperative Learning Strategy

Nattiv [19] put forward that cooperative learning is a teaching method, in which pupils work together in groups and face common goals. Each member is individually responsible for learning, and "rely on each other" in terms of remuneration, work, materials and roles. The group members are usually heterogeneous in achievement, gender and race. Cooperative learning is a group teaching design which combines pedagogy, social psychology, group dynamics, etc. It mainly uses the division of labor and cooperation among group members to support each other and learn. In addition, group-based assessment and the social and psychological atmosphere of inter-group competitions are used to improve learning effectiveness. The purpose is to make learning activities into joint cooperative activities, and the success or failure of the learning activities is related to the honor or disgrace of the group.

Therefore, cooperative learning has its own unique characteristics, which is different from other teaching methods. Cooperative learning is not as simple as placing pupils in groups to learn. More importantly, it involves organizing groups to promote cooperative learning within these groups. Cooperative learning is not just to let pupils sit around together and let each pupil do his or her homework. In a real cooperative learning group, members depend on each other, help each other, share resources, and promote each other's learning.

3 Method

3.1 Participants

The cohort in this study comprised second-grade pupils of an elementary school in Yunlin County. The pupils had not received any relevant STEAM education prior to this experiment. Therefore, the pupils were at the beginning stages of the STEAM courses. Two classes of second grade pupils were recruited to serve as the two groups in the experiment. There were 24 pupils in the experimental group learning STEAM courses with cooperative learning and there were 24 pupils in the control group learning STEAM courses with individual learning. The STEAM courses were offered to 48 pupils in total (see Fig. 1). Each pupil was equipped with a set of STEAM self-propelled block cars and a remote controller, which could be used after the self-propelled block car had been assembled.

3.2 Assessment Tool - Problem-Solving Ability Test

The problem-solving ability test in this study refers to the previously revised problem-solving test, with the theoretical framework improved by Shiou-Mei Chan, Wu-Tien Wu, and the problem-solving ability assessment tool developed by redesigning the form, content and scoring method of the test according to the previous testing experience. After completing the STEAM courses, the learning strategies the two groups, namely the group exposed to group learning and the groups exposed to individual learning, were different.

3.3 Experimental Process

This research experiment consisted of 24 classes taught over a period of 12 weeks. Each class lasted 40 min. In the first and second weeks of the experiment, the classes STEAM Course-Understanding Building Blocks and Building Block Assembly and Grouping of Experimental Groups were conducted to enable pupils to understand the car building block assembly and the way to build the blocks, which contained the fields of science, technology and engineering in STEAM education. This part took two weeks. In the 3rd week, the class STEAM Course-Designing Your Own Car was held to enable pupils to learn about the parts of the building block assembly car with what they learned about building block assembly. It covered the fields of science, technology and engineering in STEAM education course, which lasted for one week. In the 4th week, the class STEAM Course-Program Warm Up was held to enable pupils to understand the use of computers and what software to use to write the programs for the cars, which consisted of science, technology, engineering and mathematics and lasted for one week. The class STEAM Course-Program Scratch Exercise was held during the 5th week, with the purpose of letting pupils know how to arrange and write programs, and be familiar with the user interface and operation of the software, covering the fields of science, technology, engineering and mathematics and lasted for one week. On the 6th, 7th, 8th and 9th weeks, the class STEAM Course-Program Scratch Practice-Building-Block Car Go Straight Forward, Turn, Go in Circle and Go Back was conducted to let pupils know how to program and write programs, and learn how to write simple programs to control self-propelled cars, covering the fields of science, technology, engineering, art and mathematics for four weeks. The class STEAM Course-Program Scratch Control Contest was held during the 10th and 11th weeks. The two weeks were used to test the learning outcomes of the courses. Simple competition methods were used to understand what they have learned, including science, technology, engineering and mathematics, which lasted for two weeks. Week 12 was the last week. A Problem Solving Ability test was conducted to measure the effect of problem solving after completing the STEAM course. Data analyses were conducted immediately after the course ended.

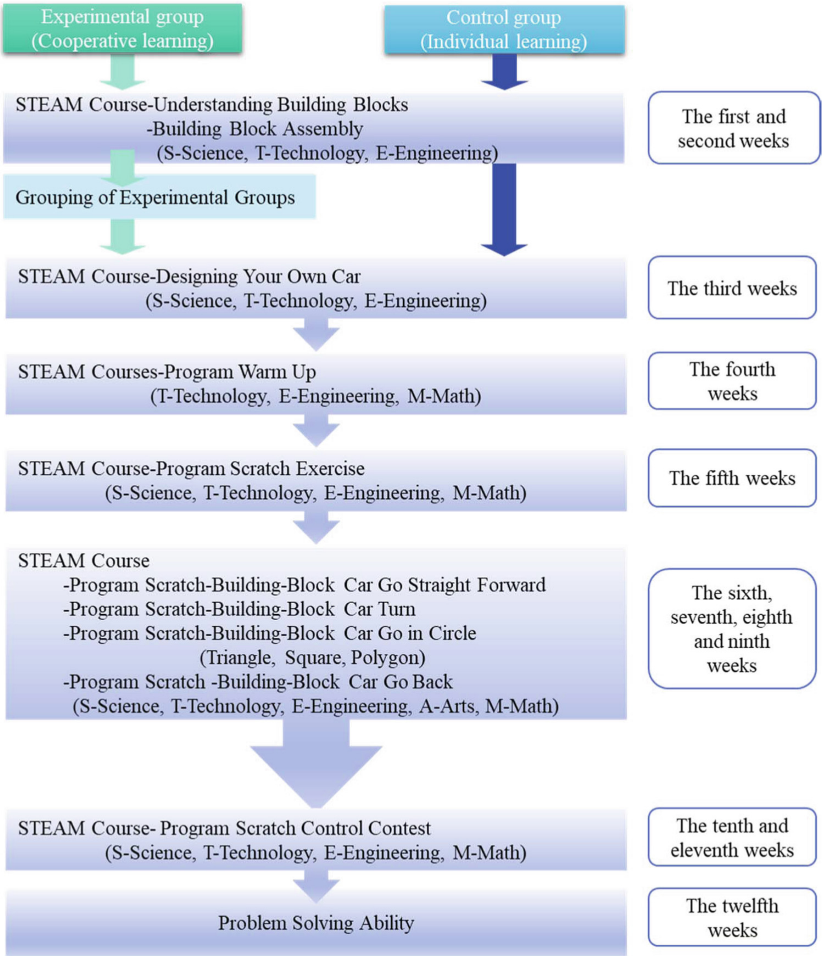

Fig. 1. Experimental process

3.4 Learning Assistive

The participants used building blocks for Cosmos Robotics Company self-propelled cars to carry out building block assembly exercises. This series of the parts are shown in Fig. 2, Fig. 3 shows the remote controller and motor set used by the self-propelled toy car. DIY Transformable Building Block Car is a set of teaching tools that can train children's creative ability in manual work and logical thinking ability. The assembly process can stimulate different imagination and creativity among the participants. In addition to allowing subjects to practice assembling building blocks, the parts group also trains hand muscles, hand-eye coordination, and cultivates the habit of concentration. After the car is assembled, the remote controller can be used to control the car. In the practice of using the remote controller, one needs to know how to match one's own remote controller with the car and the control mode, which is the application of the ability of logical thinking and mathematical reasoning. After understanding the control mode of the remote controller, participants can start to practice programming to control the movement of the cars, produce solutions or new innovative ideas, to further develop and solve problems. Through the learning of building-block cars, participants could apply what they had learned into real-life and face the challenges in the future at a higher level.

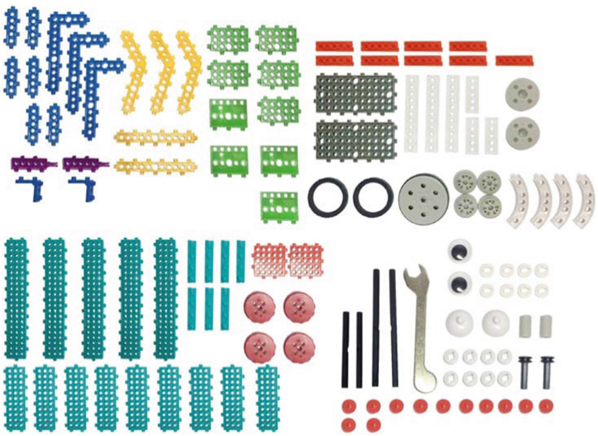

Fig. 2. The parts of D IY Transformable Building Block Car by Cosmos Robotics Company.

Fig. 3. The self-propelled car remote controller and moto.

4 Results and Discussion

4.1 Problem-Solving Ability

Figure 4 shows the data visualized as a line chart of the test scores of pupils in the problem-solving ability test experimental group and the control group. One can observe that most pupils' scores in the experimental group are higher than those of the control group, and the final average scores, the average scores of the experimental group are also higher than those of the control group.

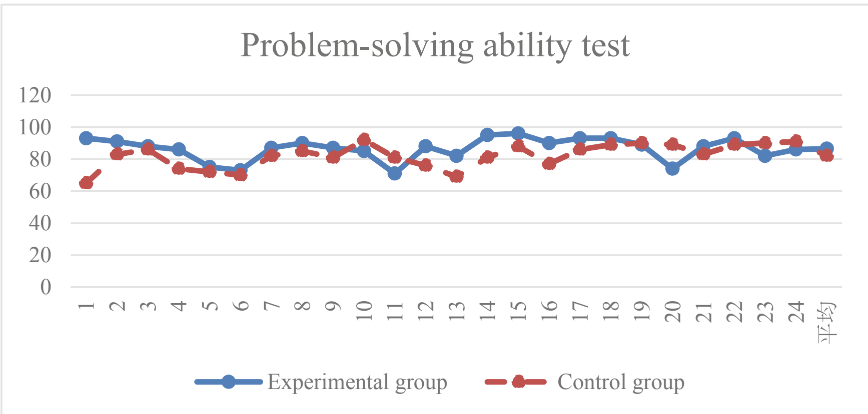

Fig. 4. Line chart of the test scores of pupils in the problem-solving ability test experimental group and the control group.

4.2 Problem-Solving Ability

After applying the STEAM course of building-block self-propelled car with cooperative learning and individual learning, the results of the learner's problem-solving ability tests were analyzed using an independent sample t-test. in order to understand the influence of learner's participation in the course on their problem-solving ability. The performances of the learner's problem-solving ability test were significantly different ($t(46) = 2.072$, $p = .44$) between the experimental group ($M = 86.46$, $SD = 7.05$) and the control group ($M = 82.04$, $SD = 7.70$). The results show that the learning strategies of cooperative learning have significant effect on problem solving after the learner has gone through the STEAM course of building-block self-propelled car in cooperative learning and self-directed learning (Table 1).

Table 1. Experimental group and control group problem-solving ability test post test score

Problem solving ability test	*Mean*	*SD*	*N*	*T*	*Df*	*p*
Experimental group	86.46	7.052	24	2.072	46	.044*
Control group	82.04	7.704	24	2.072	45.646	

$^{*}p < .05$

5 Conclusions and Future Work

The results suggest that the problem-solving ability of learners with the cooperative learning strategy yields higher problem-solving ability test scores than the independent learning strategy in context of a cross-disciplinary STEAM course involving building-block self-propelled cars. The STEAM education strategy combines the knowledge in five major fields of study, namely science, technology, engineering, art and mathematics through relevant courses to narrow the gap between different disciplines [20], and enables pupils to learn knowledge through multiple channels in different environments and project activities. The results of his study agrees with the effects advocated by STEAM education, namely improved cooperative learning, mutual discussion, communication in curriculum learning, and the improvement of problem-solving ability. It uses cross-disciplinary course learning and combines hands-on practice with innovative thinking inspiration, leading to the in-depth participation in the learning process and the promotion of learning interest. Learners' learning and absorption in the learning process can achieve better results when there is good interaction between learning methods and course learning in the learning process.

Future work includes in-depth discussion and analysis of the correlation of additional dimensions such as creative thinking, trial and errors and critical thinking.

Acknowledgments. This work is partially supported by Ministry of Science and Technology, Taiwan under grant MOST 107-2511-H-224-004-MY3, MOST 108-2628-H-224-001-MY3, MOST 108-2321-B-027-001, and MOST 108-2221-E-027-111-MY3.

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A System to Support the Learning of English Collocations via Video Materials: A Preliminary Study

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Abstract. This paper shows the functionality of an online web-based system to facilitate English collocation learning via videos along with their captions. As videos can be attractive and fun materials for L2 learners who are learning English as a foreign language, this system is hopefully able to support them to be exposed to collocations by watching videos especially in terms of drama types. After recognizing collocations used in drama videos, L2 learners can look for further explanations and instances via an online concordancer integrated into this learning system. There were also functions including knowledge sharing, online assessment, and learning portfolio. In order to detect the usefulness and usability of the proposed system, we initially identified a small sum of the users' perception as a pilot test. This preliminary result exhibited that these participants agreed the proposed system could help them learn English collocations.

Keywords: English collocation · Video captions · Online learning system

1 Introduction

Learning vocabulary combinations is proclaimed to be important when students learn English as a foreign language (L2) because there are fixed ways of putting words in order. Some are labeled as idioms whose true meaning may be difficult to be inferred from their surface wording such as "kick the bucket", but others are classified as collocations which can be guessed or inferred from the individual keywords. Expressions like "strong coffee", "strong tea", "do homework", and "take photos" are normally well stored in the mental lexicon of native English speakers and can be used naturally.

However, L2 learners may misuse them because of their first language (L1) interference. Take the students whose L1 is Chinese as an example: their habits of using English as an L2 may result from different rules or habits of using L1 which may

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 58–67, 2019.
https://doi.org/10.1007/978-3-030-35343-8_7

not always conform to the English usage. For example, beginners easily misuse “taking medicine” as “eating medicine”. Similarly, “having here” means “in-store dining”, yet Chinese students may misuse it as “eating here”. Therefore, for these learners, it is important to notice and overlearn collocations to render natural, fluent spoken or written English.

Regarding how L2 learners improve their knowledge to form correct collocations, quite a few studies used the corpus in English courses to train students to strengthen their English knowledge, and then confirmed the effectiveness of the corpus application [1].

It was also considered that the dialogues in English drama-type videos can contain interesting, authentic and daily use of conversations [2]. Since there are complex ways to connect words in one’s mind [3], without a doubt, the more collocations can be provided, noticed, obtained and linked to situations, the more collocations may be used properly.

Therefore, this study aims to develop a learning system which combines the use of English drama videos, collocation dictionaries, and the retrieval of the corpus. The system puts these functions together to draw L2 learners’ attention and strengthen their knowledge so that the use of English collocations can be more near-native.

2 Related Works

2.1 The Relation Between Collocations and Vocabulary Acquisition

Much evidence has shown that L2 learners with good vocabulary ability have an advantage in listening, speaking, reading and writing, so numerous methods of how to improve individual single-word ability were proposed [4, 5]. However, it was pointed out that the ability of L2 learners to produce collocations was not necessarily synchronized or equal to the growth of their single-word ability, and the development of collocations would be slower than the development of single words [6]. In other words, collocation development takes longer time than single-vocabulary development, and the difficulty is greater as well.

It was also found that the number of collocations used by advanced English learners was still much lower than that of native speakers, and when they used collocations, many errors were made. Therefore, it is important to keep looking for useful methods to teach L2 learners to use more of correct collocations.

As quite a few studies suggested that collocation patterns can be gradually acquired through the training of writing, learners were advised to use collocation dictionaries to search for commonly used collocations. In addition, with the advance of information technology, an approach called Data-Driven Learning was proposed to allow learners to explore the corpus of collocation construction in large collocation data. Different from using the dictionary, the corpus provides a web operation interface for learners to search for single words with more phrases and examples, and this enables learners to establish more collocation knowledge [1].

Although the corpus helps L2 learners search and learn a large number of collocations, this method will require much of learners’ intention or motivation to look up for the information. Moreover, the examples in such a data bank are still fragmental without giving the classified or suitable written contexts for learners, especially for those at lower levels of language competence, so they may lack the motivation to learn collocations actively.

2.2 The Effect of Video on Language Learning

Videos are recognized as useful materials for L2 learning. There is no doubt that videos could improve L2 listening skills and vocabulary acquisition [7, 8]. Furthermore, one study showed that forty students whose native language is Chinese, after watching English video-based Internet materials, significantly improved their learning, compared to the students who listened to the spoken sounds only [9].

While watching videos, captions can be helpful for L2 learners. Video captions have been defined as the on-screen text appeared in the L2, while subtitles should be in the native language [7]. When watching video captions, L2 learners may increase the chance of encountering more L2 words. In addition, video captions could be more interesting and authentic input than printed texts in books. A study exhibited that captions are important to raise the L2 vocabulary proficiency level while learning video-based materials. The results showed that the achievement of learning vocabulary was significantly strengthened by learning full-caption mode and target-word caption mode, compared with non-caption mode. In addition, participants agreed that watching the video captions is more interesting than reading textbooks [10]. In particular, as mentioned, L2 learners normally find drama videos fun and enjoyable [2]. Therefore, considering that collocation acquisition seems to be more difficult than typical and single vocabulary acquisition [6], our study aims to develop a video-based learning system to support English collocation learning.

3 System Design

3.1 System Feature and Structure

The characteristics of our designed system are as follows.

- Recommending the video sources: The designed system provides a list of video recommendations that L2 learners in Taiwan can easily and legally get access to.
- Identifying the collocations that appear in video captions: The designed system highlights the collocations of video captions. The system can help learners identify collocations in a sentence or a conversation. If learners wonder about any collocations, they can develop the motivation to learn more about them via the online concordance.
- Integrating online concordancer: As web concordancers are useful software tools to search for knowledge and examples of vocabulary, our system incorporates the online concordancer called Compleat Lexical Tutor [11]. After identifying a collocation in the video captions, learners are also able to link it with this lexical item to search for more references and examples of the collocation in the BBI dictionary [12], which is a classical representation of collocation dictionaries.

- Tracing learning history: The history of learning can be recorded in a personal portfolio.
- Self-assessing: The system supports online quizzes containing the collocations in the videos. Regarding the questions that are not answered correctly, learners can view the correct answers and learn these collocations again.
- Sharing annotation: Learners are encouraged to share their identified collocations in the videos. For such purpose, the designed system supports an online annotation sharing function. Once learners identify a collocation, they can comment on the patterns of the collocation composition such as verb + noun (V-N). Learners are also encouraged to provide examples of collocations. Other learners can read the comments and provide feedback.

Figure 1 shows how these characteristics are formed. The system is divided into three layers: Learner Management Site, Core Service, and Database. The system was developed in the format of web applications. In the learner management site, learners can manipulate the web pages to store or retrieve the records to/from databases such as online quizzes, annotations of collocations, comments, and responses.

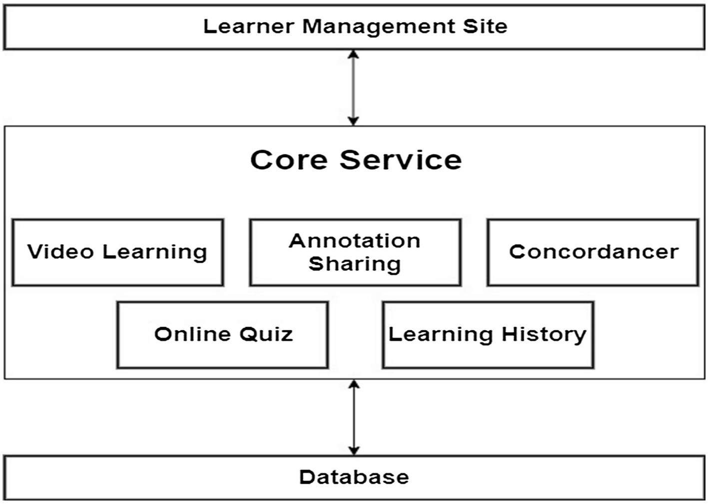

Fig. 1. System structure

Figure 2 shows the functionality of the learning system. Once new users sign up the system, they can sit for an online pretest to recognize their starting stage of the collocation competence. The second step is to receive online training to learn the fundamental knowledge of collocation and combination types. Learners are able to realize how collocations are defined. After the training, learners can start to choose their favorite videos to watch and learn. Once they find interesting collocations highlighted in the video captions, they can link the provided web concordance so that they can search for more information and examples of the collocations. Moreover, they can create and share comments on the collocations with others. The system provides them with a space to comment on the types of the collocation as well as the examples. After posting the annotations, learners can view the feedback of their peers. They can also comment on peer feedback. Online assessments of each video are also offered. Thus, each learner can sit for several online quizzes to detect his or her current collocation proficiency. Furthermore, each learner can trace what he or she has learned.

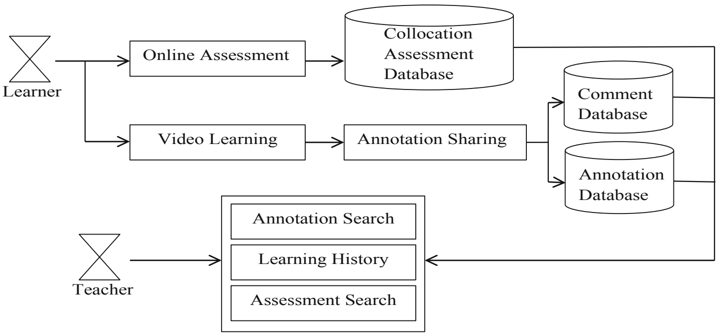

Fig. 2. Operational process

4 System Implementation

4.1 Learning Process

After learners log on the system, they can select the video learning mode. A series of videos are listed in the system. Once a video is chosen, the system displays a list of collocations that appear in this video (see Fig. 3). Every item in this list consists of two parts: a hyperlink to an online concordancer and a link to the collocation's appearance in the video. The purpose of this function allows learners to have preliminary learning of collocations before watching a video. They can click the hyperlink of the collocation to learn the item in the online concordancer, or watch the video clip and caption that contain this collocation. As mentioned, while watching the video, learners can use the SEARCH function of the system to learn the collocation knowledge in the BBI dictionary.

Fig. 3. The list of collocations in a video

Figure 4 presents the function of annotation sharing. Although the system has pre-selected quite a few collocations listed in the BBI dictionary in the caption, learners are encouraged to recognize more of the collocations which are not pre-highlighted on the caption of the video. Once a learner recognizes the collocation, he/she can share the finding with other peers. In the function of annotation sharing, a learner can post different collocations with the corresponding grammatical or lexical patterns with examples. The system also offers a service to allow a learner to view all recorded annotations. The name of this service is Personal Concordancer. This service supports four modes: the latest annotations, personal annotations, annotations in the individual video, and all annotations. In the first mode, a learner can view the latest annotations released by all users. Moreover, a learner can view the list of annotations created by using the second mode. In the third mode, a learner can review the collocations highlighted in the individual video. Finally, the last mode can list all annotations recorded in the system.

Fig. 4. Annotation sharing

Figure 5 shows a partial screenshot of designing the online assessment in the system. A quiz contains ten questions. Possible answers are randomly displayed in a list numbered from one to ten for learners to fill in. The question type is the fill-in-the-blank style. Each question is described in Chinese (L1) and English (L2). All the questions are from the captions of the video. After the answers are submitted, the online assessment tool displays the questions that are not answered correctly, and then the learners can view the correct answers to those questions. In addition, every answer has the corresponding hyperlink to online concordance, and the learners can watch the caption of the video that contains this collocation.

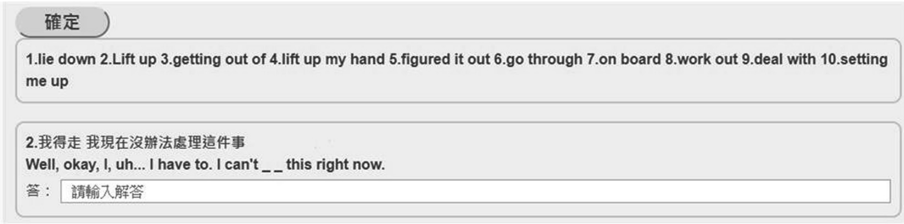

Fig. 5. Online assessment: an example of designing a test

4.2 Instructor's Management Tool

The system also supports the function of management for teachers. They can utilize this section to monitor each student's learning progress. After selecting a student, they can browse the student's portfolio that contains a history of chosen videos, annotations, and the results of collocation tests (see Fig. 6).

Fig. 6. The portfolio of a learner

5 A Pilot Test

As the system was recently completed, a preliminary experiment was conducted to investigate university students' perception after trying this collocation learning system. Eight university students who were taking the English language as a major at a university in the central city of Taiwan voluntarily spent around 8 h at the computer lab. At first, the participants were introduced to the concept of collocations and the proposed learning system. Then they did self-learning. Finally, they completed a questionnaire modified from a former study that could test users' perception of usefulness and usability of the system [13]. The current questionnaire adopted the 5-point Likert scale ranging from the scales 1 to 5 to represent each response level of strong disagreement or agreement.

5.1 Results

Table 1 shows the results of the first eight questionnaire statements focusing on the usefulness of the collocation learning system. The average mean value exceeded 4. This indicates that the students found the system useful. Moreover, the responses to statements 5 and 8 obviously show that they believed the proposed system could improve their collocation learning. However, the first statement had a mean score of 3.87 which is the lowest one, so this may imply that the subjects considered a teacher's role can still be very important in the learning process.

Table 1. The statistics of usefulness scale

Question	*Mean*	*STD*
1. Using this system makes learning easier than learning with a teacher	3.87	0.64
2. This learning method helps me learn what I want at any time	4.25	0.88
3. I am very interested in such an English learning system	4.12	0.83
4. The content introduced in this system suits my interest	4.12	0.83
5. This system can help me learn English collocations	4.75	0.46
6. I like to learn collocations through this system	4.25	0.7
7. I like this system very much and will recommend it to other students	4.37	0.51
8. This system can help me improve my English collocation competence	4.62	0.51

Table 2 shows the statistics of participants' perception towards the system design. Again, almost all of the mean values of the responses were over 4, indicating that the participants were satisfied with the operation of the proposed system. However, the guidance was required to be clearer and easier according to the responses to the third statement.

Table 2. The statistics of usability scale

Question	*Mean*	*STD*
1. The font size in the system is appropriate	4.62	0.51
2. The buttons of user interfaces are clear and easy to use	4.50	0.53
3. The operational guidance in the system is clear and easy to use	3.87	0.83
4. The color configuration in the system is clear and easy to distinguish	4.12	0.83
5. The interface size in the system is appropriate	4.62	0.51
6. It is easy to understand the messages in the system	4.37	0.74
7. The video contents in the system are suitable for learners	4.75	0.46
8. I remember the learning content better by using this system	4.62	0.51
9. I like the interface design of this learning system	4.25	0.70

6 Conclusion

Different from the most commonly seen corpus-oriented instruction in the classroom, this paper proposed a major framework of designing a video learning system to support English collocation learning. First, learners are able to watch videos not only to have fun but to absorb the usage of collocations in general situated spoken discourse. Second, learners are encouraged to look up information in a data bank and/or share the findings and understanding of collocations with peers via annotation sharing, so that teachers' load can be reduced. Third, the self-assessment and learning portfolio are also supported in the system, so learners are able to retrospect to whatever learned.

Although it was only an initial stage to implement this system to learn English collocations, the pilot results exhibited positive responses from L2 learners regarding the usefulness and usability of the system. Moreover, as teachers are often confronted by unpredictable questions of collocations from students such as "agree to" or "agree with" or "agree at", this collocation system can become a convenient resource for innovative teaching. However, some of the limitations can be identified. First, the learning system currently cannot support the version of mobile APPs. Secondly, the effect of the system on collocation learning in a real teaching and learning setting is not measured yet. As L2 students in Taiwan seem to rely on the teachers' instruction to learn collocations in the system, we are looking for the appropriate approach to find out the effect.

Acknowledgments. This study is supported in part by the Ministry of Science and Technology of the Republic of China (Contract Number: MOST 107-2511-H-035-004-MY2).

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An Empirical Research on Exploring the Trans-disciplinary Autocorrelationships Among the Social-Media Technology, MOOCs and Higher-Education Sustainability

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Abstract. Base on the serious and extensive influences of declining birth-rate with rapid development of Taiwanese higher education institutions, the Taiwanese higher education institutions have started to develop the most effective MOOCs to aggressively increase comprehensive institution revenues with the lowest course costs by means of multiple digital social-media technology in order to formulate the most effective strategic sustainability for surviving in this baptism of fire. Therefore, this research intensively employed the Quality Function Deployment Method of House of Quality (QFD-HOQ) model of qualitative analysis to construct the Most Valuable Social-media Technology MOOCs Interdisciplinary Course Evaluation Model (MVSTMICEM) to induce the most valuable decisive factor of Social-media Technology MOOCs Interdisciplinary Course to deeply explore the three most critical research mainstream topics: "how to offer the most high-quality social-media technology to advance the MOOCs quality for triggering school student's self-studying interdisciplinary interests, how to supply the most the most diversified MOOCs for attracting corporate employee's self-studying interdisciplinary demands and how to provide the most multiple-disciplinary MOOCs with the diversified social-media technology for aggressively increasing higher education institution's revenues with the lowest courses costs."

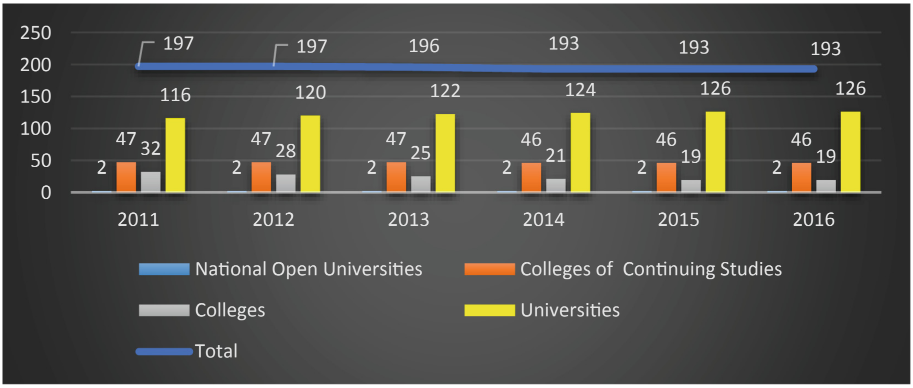
Keywords: MOOCs · Social-media technology · Higher-education strategic sustainability

1 Introduction

Beyond the serious and extensive influences of declining birth-rate with rapid development of Taiwanese higher education institutions, up to 79 departments of Taiwanese higher education institutions was zero in fresh student's register-rate and these 79 departments contain 14 public universities, 13 private universities, 3 public colleges and 5 private colleges. Significantly, the programs of these 79 departments covered 14 public universities, 13 private universities, 3 public colleges and 5 private colleges, according to the latest announced report from Ministry of Education in December 28, 2018.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 68–76, 2019.
https://doi.org/10.1007/978-3-030-35343-8_8

However, based on the latest statistic report of Taiwanese Ministry of Education in 2018, Taiwanese higher education has expended up to 190 institutions, including 126 public and private universities, 46 public and private colleges, 19 public and private continuing studies colleges and 2 public digital education open universities as describes in Fig. 1.



Resource: Ministry of Education, Taiwanese Executive Yuan

Fig. 1. Overview of current Taiwanese HE institutions from 2011 to 2016.

For effectively solving this hyper-competitive situation of declining birth-rate with rapid development of Taiwanese higher education institutions, the majority of Taiwanese higher education institutions have started to provide the most effective Massive Open Online Courses ("MOOCs") to aggressively increase comprehensive institution revenues with the lowest course costs to formulate the most effective strategic sustainability by means of the diversified employments of multiple digital social-media technology in order to survive in this baptism of fire.

For the reason, the three essential research mainstream [1–3] topics ("how to offer the most high-quality social-media technology to advance the MOOCs quality for triggering school student's self-studying interdisciplinary interests" [4, 5], "how to supply the most the most diversified MOOCs for re-attracting corporate employee's self-studying interdisciplinary demands" [6–9] and "how to provide the most multiple disciplinary MOOCs with the diversified social-media technology for aggressively increasing higher education institution's revenues with the lowest courses costs." [10]) were going to be assayed in this research for exploring the Trans-disciplinary Autocorrelationships among the Social-media Technology, MOOCs and Higher-education Sustainability.

Comprehensively, in increment of research validity and representativeness, this research applied the three analytical perspectives: "triggering school student's self-studying interdisciplinary interests", "re-attracting corporate employee's self-studying interdisciplinary demands" and "increasing higher education institution's revenues with the lowest courses costs" for systematically advancing the research validity. Continuously, this research has intensively employed the Quality Function Deployment

Method of House of Quality ("QFD-HOQ") model of qualitative analysis [11] to hierarchically assessing the weight-questionnaires of 20 experts in order to construct the Most Valuable Social-media Technology MOOCs Interdisciplinary Course Evaluation Model ("MVSTMICEM") for inducing the most valuable decisive factor of Social-media Technology MOOCs Interdisciplinary Course to deeply explore the three most critical research mainstream topics [12–14].

2 Lecture Reviewing

At present, in order to effectively supply the higher quality of multidisciplinary courses for "triggering school student's self-studying interdisciplinary interests" to increase the Taiwanese higher education student's interdisciplinary employability and "re-attracting corporate employee's self-studying interdisciplinary demands" [15] to cultivate the employee's competencies, Ministry of Education and Ministry of Economy Affairs, Taiwanese Executive Yuan have cross-department constructed seven MOOCs platforms for directly provide a series of professional digital education courses and on-job training programs according to the swift development and popularization of information, wireless, telecommunication technologies. Therefore, the majority of MOOCs participants (students and employees) not only surf and download up-to-date information and knowledge in course but also share and upload, in the meanwhile, learning and lecturing situation and information form these MOOCs by means of current popular computer, communication and consumer ("3C") electronics devices with the technological functional services of these information, wireless, telecommunication technologies anytime and anywhere. Moreover, the MOOCs participants are able to easily break through the traditional restrictions of time and space limitations. Significantly, each MOOCs participants are also able to be always duplicably re-taken through digital platforms of MOOCs and for the reason, Taiwanese higher education institutions definitely employ this digital educational characteristics of MOOCs to create the highest profits and benefits with the lowest courses' costs and expenditures. In sight of Taiwanese MOOCs, these MOOCs covers the Small and Medium Enterprises Learning website ("Smelearning") and the Industry-university Cooperation Talent Training Information Website ("IUCTTI") of commercial pursuits as well as Taiwanese Institution of Information Industry, III ("III Proera"), Homogeneous Educational Platform ("HEP"), National Tsing Hua University, NTHU ("NTHU sharecourse"), National Chiao Tung University Ewant ("NCTU ewant"), National Chiao Tung University Taiwan Life ("NCTU Taiwan LIFE") and National Taiwan University ("NTU Coursera") as expressed in Table 1.

With best solution to the three essential research mainstream topics ("how to offer the most high-quality social-media technology to advance the MOOCs quality for triggering school student's self-studying interdisciplinary interests", "how to supply the most the most diversified MOOCs for re-attracting corporate employee's self-studying interdisciplinary demands" and "how to provide the most multiple disciplinary MOOCs with the diversified social-media technology for aggressively increasing higher education institution's revenues with the lowest courses costs."), there are a series of critical decisive elements from the three analytical perspectives ("triggering school

Table 1. Summary of current Taiwanese MOOCs.

Attributes	Main description of Taiwanese MOOCs
Commercial pursuits	➢ Firstly, the Smelearning (https://www.smelearning.org.tw/) was created from the technological education website of "Promoting small and medium enterprise digital education program" of "Small and Medium Enterprise Administration" of "Ministry of Economy Affairs" ➢ Secondly, the IUCTTI (http://hrd.college.itri.org.tw/coedu/) was founded from the industrial promoting training program of Industrial Development Bureau and Industrial Technology Research Institution, Ministry of Economy Affairs for designing the interactive technological education platform between academic institutions and empirical companies because the majority of talent employees do focus on the developed increment of employability and competency after working for companies
Academic pursuits	➢ Firstly, the "III Proera" (http://www.proera.com.tw/) was innovated by Taiwanese Institution of Information Industry (III) through a cross-cooperation with the Association of e-Learning (AEL) and Tamkang University for providing diversified technological education platforms through digital technology. Subsequently, Proera also further cooperated with sharecourse in order to provide a more effective and efficient digital education websites of MOOCs ➢ Secondly, the "HEP" (http://www.junyiacademy.org/) was initiated by the Alliance Cultural Foundation (ACF) and Social Enterprise Insights (SEI) and these has been utilized to share more than 2,000 Taiwanese lecturing technological education videos of related science subjects in over 60 MOOCs course. Furthermore, it also offers a set of system for lecture in order to stimulate school student's self-studying interdisciplinary interests ➢ Thirdly, the "NTHU sharecourse" (http://www.sharecourse.net/sharecourse/) was founded by the National Tsing Hua University founded the NetXtream Technology Company on August 2008 created the "share-room" for expanding the online discuss space, shareroom and then, the sharelive for relaying a radio or TV broadcast ➢ Fourthly, the "NCTU ewant" (http://www.ewant.org/) was founded by the technological platforms of the National Chiao Tung University ("NCTU") for MOOCs course in January 2013 and created the "ewant" MOOCs websites in connection with four China universities (Shanghai Jiao Tong University, Xi'an Jiaotong University and Southwest Jiaotong University and Beijing Jiaotong University) to inaugurate the first technological learning education cooperation project ➢ Fifthly, the "NOU Taiwan LIFE" (http://taiwanlife.org/) was founded by National Chiao Tung University ("NCTU") and National Open University ("NOU"). These further offers 40 technological education courses with the cooperation of 15 Taiwanese higher education institutions. Therefore, Ministry of Education founded MOU to provide digital academic courses as well. The entire responsibilities of the development of digital education was assigned to NCTU ➢ Sixthly, the "NTU Coursera" (https://www.coursera.org/) was invented in August 2013, National Taiwan University ("NTU") first pioneered two Chinese MOOCs classes, "Possibility" and "Chinese Traditional History and Famous Person- Qin Shi Huang" that broke the English language learning barrier for of Taiwan participants

Source: Integrated by author.

student's self-studying interdisciplinary interests", "re-attracting corporate employee's self-studying interdisciplinary demands" and "increasing higher education institution's revenues with the lowest courses costs") to be considered as assessed criteria in order to induce the most valuable decisive factor of Social-media Technology MOOCs Interdisciplinary Course to deeply explore the three most critical research mainstream topics [16–18]. For the reason, the main critical analytical criteria are the "Application Programming Interface ("API"); Content Reality ("CR"); Conversations Feature ("CF"); Device accessibility ("DA"); Identity feature ("IF"); Individual Social Feature ("ISF"); Keyword-search Engine ("KE"); Multiple Device Accessibility ("MDA"); Social networking Communication Channel ("SNCC") and Web 3.0 (W3)" [19–21]. Then, the appraised criteria of "triggering school student's self-studying interdisciplinary interests" are the "User Completely Unrestricted operation ("UCUO"), Convenience ("C"), Connectionization ("CZ"), Openness ("O"), Course complete Rate ("CCR"), Feedback Technology Function ("FTF"), Course Evaluation Technology Function ("CETF"), Aggregation Technology Function ("ATF"), Course Professionalization Technology Function ("CPTF") and Re-purposing Technology Function ("RTF")" [22, 23]. Subsequently, the assessed criteria of "re-attracting corporate employee's self-studying interdisciplinary demands" are the "Aggregation Technology Function of Basic Function ("ATF-BC"), Course Evaluation Technology Function of Course Function ("CETF-CF"), Course Professionalization Technology Function of Course Function ("CPTF-CF"), Feedback Technology Function of Basic Function ("FTF-BF"), Re-purposing Technology Function of Basic Function ("RTF-BF"). Eventually, the evaluated criteria of "increasing higher education institution's revenues with the lowest courses costs" are Connectionization of Course Operation ("C-CO"), Openness of Course Content ("O-CC"), Convenience of Course Operation ("C-CP"), Course Complete Rate of Course Assessment ("CCR-CA") and User Completely Unrestricted Operation of Course Operation ("UCUO-CO") [24, 25] ".

3 Research Design

3.1 Research Design Steps

With reference to analysis and evaluation of QFD-HOQ model of qualitative analysis to hierarchically assessing the weight-questionnaires of 20 experts in order to construct the MVSTMICEM model for inducing the most valuable decisive factor of Social-media Technology MOOCs Interdisciplinary Course to deeply explore the three most critical research mainstream topics [26]. There are four essential research steps to be designed as (1) First research step: Planning and constructing evaluated model (the MVSTMICEM model); (2) Second step: Executing the methodological methods; (3) Third step: Reviewing evaluated model by revising the evaluated model and (4) Forth step: Concluding the evaluated consequences for extensively promoting research results as presented in Fig. 2.

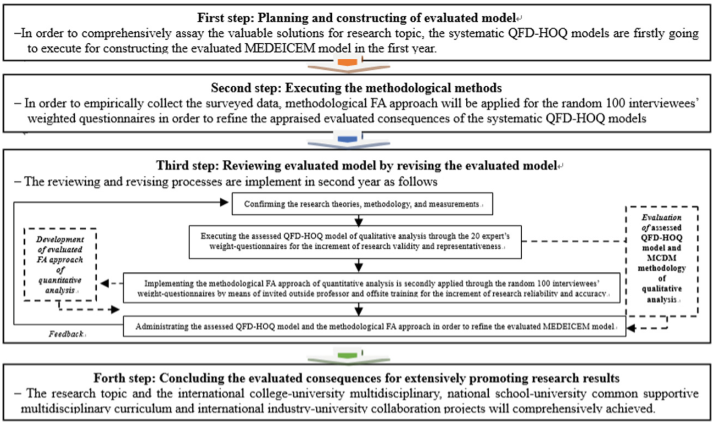


Fig. 2. The essential four research steps.

3.2 Research Data Collection

In association with the higher reliability and representativeness, the research interviewees of questionnaire-data collection were employed as Delphi method, the collected questionnaires are at least over 20% of surveyed data by the research results of Dalkey and Helmer in 1963. For the reason, the three questionnaire interviewed groups were collected with reference to the three analytical perspectives ("triggering school student's self-studying interdisciplinary interests", "re-attracting corporate employee's self-studying interdisciplinary demands" and "increasing higher education institution's revenues with the lowest courses costs") related to each assessable criteria. Continuously, the 20 experts and professionals were interviewed for the weight-questionnaire assessments of QFD-HOQ models of qualitative analysis in order to comprehensively construct the evaluated MVSTMICEM model [27, 28]. In view of "triggering school student's self-studying interdisciplinary interests", "re-attracting corporate employee's self-studying interdisciplinary demands" and "increasing higher education institution's revenues with the lowest courses costs" [29, 30], these 20 experts and professionals contains 5 senior scholars who did over 10-year researches in MOOCs interdisciplinary research fields, 5 international senior professor who have over 10-year lecture in MOOCs interdisciplinary courses, 5 international senior professionals who have over 10-year experience in MOOCs interdisciplinary structural system and final 5 international senior managers who have over 10-years in interdisciplinary of empirical companies.

4 Research Measurement

4.1 QFD-HOQ Models of Qualitative Analysis

The definition of the classic QFD-HOQ model in this research are described as completely constructed step-by-step to measure the appraised matrices: WHATs and the related importance ratings of the WHATs, the HOWs and the related importance ratings of HOWs, and relationship matrix between WHATs and HOWs through the comparison of MCDM measurement. Hence, according to Fig. 2, W1 matrix points out a vector which expresses the influence of the research topics, which meet the satisfaction of WHATs. From a customer needs perspective, W2 matrix is the assessed matrix that presents the influence of WHATs on each HOW. The W3 and W4 matrices separately express the appraised matrices of the internal dependence of entire WHATs, entire HOWs and the evaluation of scholars and experts as presented in Fig. 3.

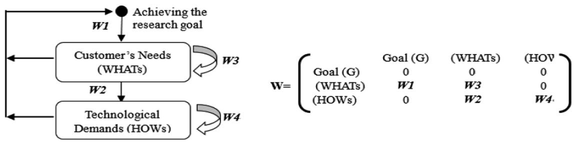


Fig. 3. Supermatrix of integrity of QFD-HOQ methodology.

5 Research Measurement

This research attempts to induce not only in the research innovative consequences but also in the accumulation of offsite training experience for research topic: "An Empirical Research on Exploring the Trans-disciplinary Autocorrelationships among the Social-media Technology, MOOCs and Higher-education Sustainability." Specifically, based on Fig. 3, the main contributive conclusion is not only MVSTMICEM) to induce the most valuable decisive factor of Social-media Technology MOOCs Interdisciplinary Course to deeply explore the three most critical research mainstream topics but also C-CO ("Connectionization of Course Operation"), O-CC ("Openness of Course Content") and CCR-CA ("Course Complete Rate of Course Assessment") are the top three critical factors of MOOCs.

Acknowledgement. This research was supported by research project (NTCU108107) of academic research supporting project National Taichung University of Education in Taiwan.

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ETAR: An English Teaching Assistant Robot and Its Effects on College Freshmen's In-Class Learning Motivation

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Abstract. Educational robots have become popular and mature in lots of Robot-Assisted Language Learning (RALL) applications in recent years. This paper reports the development of an English Teaching Assistant Robot (ETAR) and its effects on in-class English learning motivation for the first-year university students in Taiwan. The study uses the social robot NAO, with voice and interactive functions, as a classroom assistant to help teachers to train students' spoken English in the classroom, including single-word and text reading aloud practice, sing-a-song as well as rollcall in class. After a six-week experiment, the results show that the introduction of the ETAR to the freshman English class improved students' English learning motivation. Moreover, the teachers' burden of some fixed mechanical work such as rollcall, word pronunciation, and text reading aloud practice can be reduced, and then teachers can have more energy to take care of more low learning-achievement students.

Keywords: English as Foreign Language (EFL) · Robot-Assisted Language Learning (RALL) · English Teaching Assistant Robot (ETAR) · Learning motivation

1 Introduction

With the rapid development of Information Technology (IT), many social robots have been produced and can be seen in public, such as robots NAO, Pepper, and Zenbo. Social robots are also increasingly used in education. For example, a public library in Taiwan uses NAO [1] robots to tell children stories to attract children's attention [2]. The New Taipei City Government in Taiwan uses Zenbo to provide guided tours, hospitality, and municipal propaganda services to serve the public [3] to reduce the consumption of human resources such as tour guiding and welcoming. NAO robots have also been used as classroom aids [4]. For example, NAO robots taught students to learn social courtesy by talking with teachers. As for the application of robots in education, much of the previous research in Robot-Assisted Language Learning (RALL) [5] proposed that RALL can make effective teaching and learning. From the

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 77–86, 2019.
https://doi.org/10.1007/978-3-030-35343-8_9

study of [6], robots helped teachers and did some roleplays with students. It compared the impact between non-computer media (using books and tapes), network-based teaching, and home robot-assisted learning on children. The robot gestured and spoke in English, and if children could not recognize its voice command, they could touch its monitor. Compared to other learning methods, HRI (Human-Robot Interaction) has an advantage in promoting and improving children's attention, interest and academic performance. Thus, if robots can be introduced to help teachers do monotonous tasks in the classroom, such as reading vocabulary, texts, roll-calling, and announcing notices, the burden of teaching can be reduced.

In Taiwan, a study [7] showed that students were able to read only 70 words per minute, and the ability to read English was generally not high. In this context where English is taught as a foreign language (EFL), university teachers often use English textbooks published by well-known publishers for their courses, such as Longman, Oxford, Cambridge, etc. However, many students still have poor English performance, and they do not understand very well regarding the benefits of English textbooks. As a result, whether university freshmen can effectively improve their English ability in a short time can be an important research goal.

The current study employs a social robot NAO with voice and interaction functions as a classroom assistant, called English Teaching Assistant Robot (ETAR), to attract freshmen's attention and enhance their motivation. The ETAR can help teachers to coach students' oral English exercises in the classroom such as pronouncing words, reading texts aloud, and managing rollcall in the class. It can also attract students' attention by means of acting and singing, and it also incorporates speech recognition and many touch functions, so that teachers and students can interact with the robot during the process by touching the hands/feet of the ETAR. Therefore, hopefully, teachers may save some, if not all, energy from doing mechanical training like pronunciation and reading aloud. The paper will report the design of the ETAR and the class experiment in the following sections.

2 Features of English TA Robot (ETAR)

The ETAR is an educational robotic system based on NAO social robots. It aims to attract students' motivation in English courses and reduce teachers' burden. The system is developed by the research team of the Department of Information Engineering and Computer Science and the Department of Foreign Languages and Literature. The system has several functions including rollcall, acting, singing, single-word pronunciation, text reading aloud practice, reading comprehension test, conversation test, and PPT teaching mode. These major functions will be shown as follows.

Rollcall: Teachers must log in first before they start the class. The ETAR will confirm the identity of the teacher and include relevant course materials such as student list, course progress, and course content. When the teacher starts the ETAR rollcall function, it will ask, "Do you want to do the rollcall?" to confirm whether the teacher wants to do a rollcall. It can call the student's name one by one and record the result of the rollcall. If a student is present, the teacher can continue to call the next student by touching its right hand/foot. If a student is absent, the teacher can touch its left hand or left foot to confirm that the student is absent and continue to call the next student's name. The rollcall process can also be performed by a designated student to enhance the interaction between the students and ETAR, and then certainly the teacher can reduce the workload of the rollcall.

Acting and Singing: When the course begins, teachers often need to have a fun opening remark to attract students. This goal can be achieved through some interesting activities that combine physical and oral activities. For example, acting and singing can be common methods. For example, When the singing function is activated, the ETAR will first say, "Do you need to broadcast a song to activate the atmosphere?" The teacher can answer, "yes", and it will say, "Then I will play the song XXX now". The ETAR plays songs and dances with the song or makes some interesting and vivid body movements to attract students' attention. The whole class including the teacher can follow and dance with the ETAR, which can enhance students' interest in the class, help students learn English by singing and build up a better teacher-student relationship. In order to increase students' interest and interactivity, and not to bore students with fixed English songs arranged by teachers, our system also provides the voting function of the songs based on students' choice. When technicians update the content of the ETAR songs, students will be able to hear various English songs they like to listen to next time, so they will be more motivated to attend classes.

Single-Word Pronunciation Practice: After the acting and singing are finished, the course will proceed to single-word pronunciation practice. At this time, the ETAR says, "Please touch my forehead to start single-word pronunciation practice", and then enter the "rest" state to wait for the teacher's further command. The teacher can distribute the word list, the unit article, and the answer choice sheet of the test in advance for students to learn in class. After confirming that the students have received the material, the teacher can touch its forehead to begin the single-word pronunciation practice. In this practice, the ETAR will lead the students to practice the pronunciation of each word according to the course syllabus. For example, the ETAR says, "Starting the practice, unit 2–City Living", and then it starts to read every word on the word list of the unit, and leads the students to follow it and repeat the word. Between two single words in the wordlist, there is an interval of three seconds to allow students to have time to read aloud the words.

Text Reading Aloud Practice: English teachers can normally notice that some students in the classroom often skip reading some words in the text, or they read vaguely about difficult words. Some words were just whispered. However, because in the previous stage, students follow the ETAR to practice the pronunciation of words, which can help them in the text reading aloud practice, so hopefully students will not pause or be vague again because of the unfamiliar pronunciation of the words. When guiding students to read texts, the ETAR will first give the instruction by saying, "Now I start to play a text file. From time to time, there are pauses to wait for you to read. To continue to listen and read after each pause, please press my right hand". Regarding the source of the reading texts, the teacher needs to previously install them into the ETAR memory. When the reading aloud exercise is carried out, the teacher asks students to read the text aloud with the ETAR. In the reading-aloud process, the teacher does not always have to operate it by himself/herself. Instead, he or she can designate a student to come to the stage to operate it. After the reading aloud stage is about to finish, the ETAR will prompt the teacher to decide whether the teacher wants to repeat the exercise or end the current text to go to the next teaching stage to do reading comprehension tests. The teacher can decide whether students have to repeat the same reading unit or go to the next text according to students' reading outcome.

Reading Comprehension Test: After the text reading aloud exercise, in order to detect students' comprehension of the text content, and to give students moderate pressure so that they can concentrate in class, there is a reading comprehension test. Before this test, the ETAR will first prompt, saying, "The course is finished. Please touch the front of my head to start the reading comprehension test." The teacher then asks the student assistant to distribute the answer sheet. The reading comprehension test requires students to indicate the answer to each four-choice question. The questions of the test are read by the ETAR. The teacher touches its forehead and it begins to read the questions of the test. Each question will be read twice and separated by a 2-second interval to ensure that the students can hear clearly. After it finishes reading each question, it is necessary for the teacher to confirm whether a student completes the answers. Afterward, the ETAR will begin the teaching phase of conversational exercises.

Conversational Practice: The questions of the conversational exercises are identical with those in the reading comprehension test, but the teacher can make the ETAR and the students have more interactions in the classroom by randomly selecting students to work on the practice with it. It will pause the exercise and wait for the next student to practice conversation during the interval between each question. During the practice, the designated student touches its forehead, and it waits for one second to read the question. Then it will prompt, "Which answer do you select?" and wait for the student to say one answer A, B, C, or D out loud. It will then ask the student to read the complete sentence, immediately identify the correction rate and speech rate of the student's answer and respond to him/her.

Powerpoint Teaching Mode: Teachers can use the ETAR's PowerPoint teaching mode in the classroom. The ETAR's operators can make the robot enter the receiving mode. The teacher uses a laptop projection and plays the PowerPoint with the ETAR's window program. The teacher can pre-write the memo draft on each page of the slide and then the robot will read the page when the teacher operates its window program. The memo of each page of the slide can be automatically detected and the speed of the robot can be adjusted according to the teacher's operation. Besides, selecting different languages such as Chinese or English is also allowed.

3 The Experiment

This study developed a set of ETAR functionality to assist not only students but to relieve teachers' workload in an EFL classroom setting. Through the ETAR's cute appearance and interaction process, the study hopes to decrease students' unwillingness or reluctance to speak English, and to improve students' motivation in classroom English learning, so that teachers may feel more relieved.

3.1 Participants and Process

The subjects of this study were selected from Freshman English class at a university in central Taiwan, with a total of 29 students majoring in science-related subjects. The entire process of the experiment lasted six weeks. The class teacher and students in the experiment met two hours per week. The first and sixth week were pre-test and post-test respectively, and the English learning motivation questionnaire was conducted. The four weeks in between the process were the ETAR-assisted teaching experiments with each unit studied per class-meeting per week, and 20–30 min for one unit was allocated separately during each class meeting. The operation of the ETAR was in principle the responsibility of the teacher, but as the number of students was not small, two technicians were there to instruct the students to operate it.

At the beginning of each class, the teacher would scan the QR-code to log in to the teacher-specific account. The ETAR would get the teacher's teaching progress. The teacher could decide whether to do the rollcall according to the students' attendance status. The teacher could also observe whether the students were concentrated; if not, the teacher could use its "acting and singing" function to attract students' attention. Then the teacher began to teach according to the syllabus. Each unit had two compulsory parts: single-word pronunciation practice and text reading aloud practices. Moreover, each week, the teacher assigned several, if not all, students to interact with the robot to increase students' interest in learning when there was time.

The focus of this study was to explore the impact of the ETAR on the students' motivation in an EFL classroom. The questionnaire was used as the main instrument to explore whether the learning motivation could be enhanced after the ETAR appeared.

3.2 English Learning Motivation Questionnaire

Motivation is a process in which people are led by the driving force to do one thing [8]. Through self-motivation or encouragement from others, people will have an idea that "I can do it" and be driven by the thinking to move toward this goal. However, the internal motivation will not stay the same; instead, it will increase or decrease with the passage of time and the number of successes or failures of the things done. Researchers generally believe that motivation is one of the key factors that affect learning speed and success.

The motivation questionnaire used in this study was produced using the version designed by Professor Dörnyei [8]. We selected the questions suitable for this experiment to produce a new version. Dörnyei's questionnaire distinguishes between major facets: tools, knowledge, travel, communication, social, cultural and comprehensive aspects, and the scholar also emphasizes the importance of having future imagination. We selected 23 questions out of 67 questions from his questionnaire model. Finally, due to the smaller number of questions in the categories of travel and social-cultural aspects, the first question and the second question were incorporated respectively into the factors of communication and knowledge. As a result, the questions could be categorized as 4 factors: Knowledge (Questions 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 19, 20, 21, 22, 23), Travel (Question 1), Communication (Questions 13, 16, 17, 18), and Cultural and comprehensive aspects (Question 2). We used the 6-point Likert scale as the measurement scale: 1 stands for strongly disagree, 2 for disagree, 3 for not quite agree, 4 for basically agree, 5 for agree, and 6 for strongly agree. Regarding the reliability of the questionnaire, the Cronbach α coefficient is 0.9 and 0.89 for the pre-test and the post-test, respectively. Both results are greater than 0.7, indicating a high level of internal consistency for the questionnaire scale.

4 Results and Discussions

4.1 Questionnaire Analysis

To respect the students' privacy to give real responses without pressure, the questionnaire of this study was filled out anonymously. We used SPSS "one-sample T-test" to detect the difference between the responses to each question for both pre- and post-tests. Table 1 lists the means of the pre- and post-tests of the experimental class.

Table 1. Differences in English learning motivation questionnaire.

No	Questions	Pre-test	Post-test	*D*	*t*	*p*
1	I like to go to countries where I can use English every day	4.38	4.40	0.020	0.084	0.934
2	I like to watch/listen to English audio and video programs	4.24	4.72	0.480	2.449	0.022*
3	It is very important for me to learn English oral expression because I can be admired by others	4.34	4.60	0.260	1.592	0.124
4	Learning English oral expression is very important for me to continue my studies	4.90	5.16	0.260	1.742	0.094
5	It is important to learn spoken English because the good oral expression will help me find a good job	5.07	5.36	0.290	1.915	0.067
6	I am always looking forward to learning how to speak English	3.69	3.88	0.190	0.902	0.376

(*continued*)

Table 1. (*continued*)

No	Questions	Pre-test	Post-test	*D*	*t*	*p*
7	It is very important for me to learn English oral expression because if my English speaking test score is low, I will feel embarrassed	3.83	4.08	0.250	1.053	0.303
8	The importance of learning spoken English is that it can help me achieve important personal goals (e.g., obtaining a degree or passing an English Proficiency Test)	4.76	4.76	0.000	0.000	1.000
9	I think it is interesting to learn spoken English	3.83	4.24	0.410	1.949	0.063
10	I can't express what I want to say by speaking in English	3.76	3.68	−0.080	−0.339	0.738
11	I feel very scared when I think that I can't speak English successfully in the future	3.83	3.92	0.090	0.368	0.716
12	I am afraid of making mistakes when speaking in English	3.90	3.72	−0.180	−0.706	0.487
13	When a foreigner asks me something in English or asks for directions in English, I can respond easily	3.52	3.80	0.280	1.252	0.223
14	I am willing to spend a lot of time learning English speaking	3.90	4.32	0.420	3.042	0.006**
15	Compared to answering questions in English writing, I prefer to use English to answer questions orally	3.90	4.28	0.380	1.727	0.097
16	I like to practice oral English with native English speakers	4.00	4.52	0.520	3.161	0.004**
17	I like to practice oral English with my classmates	3.55	4.12	0.570	2.522	0.019*
18	I can imagine the scene where foreigners and I can easily talk in English in the future	3.79	3.92	0.130	0.481	0.635
19	I can imagine the situation in which I will speak in English in public in the future	3.45	3.64	0.190	0.647	0.524
20	I can imagine that I will successfully pass the English Speaking Proficiency Test in the future	3.90	4.08	0.180	0.666	0.512
21	I can imagine the future of my working in the workplace with fluent oral English	3.90	4.08	0.180	0.666	0.512

(*continued*)

Table 1. (*continued*)

No	Questions	Pre-test	Post-test	*D*	*t*	*p*
22	I can imagine the scene in which I continue to study in school with fluent oral English	3.93	3.88	−0.050	−0.208	0.837
23	I cannot imagine much about how English-speaking skills relate to my future development	2.72	2.92	0.200	0.868	0.394

$^{*}p < .05$; $^{**}p < .01$

From the scores of questions 2, 14, 16, and 17, it is obvious that the students did improve significantly on the 3 motivational factors of Knowledge, Communication, and Cultural and comprehensive aspects. That is, the students were more willing to practice oral English with others (Q17 "Communication" factor). Moreover, they were more confident in practicing oral English with native English speakers (Q16 "Communication" factor). They were also willing to spend more time learning English speaking (Q14 "Knowledge" factor), and they also liked to watch/listen to English audio and video programs more (Q2 "Cultural and Comprehensive aspects" factor). The results may be attributed to the fact that after they had the opportunity to interact with the ETAR in class, they felt that they could speak English freely in front of the robot, found the confidence to speak English, and learned the language from the interesting interaction with the ETAR, so they were more willing to communicate with people in English, which in turn increased their interest in seeking English knowledge.

From the fact that the average mean score increases, the answer to our research question is that with the ETAR in the class, students' motivation of learning English has some obvious differences. Through the questionnaire results in the experimental group, it can be seen that the students found the importance of English after six weeks of the experiment. For example, for Question 7, although not significant, the average mean of the pre-test and post-test is increased. The students also realized that spoken English is very important for them to continue their study or work. The score is also rising in regards to knowledge. Therefore, this may indicate, first, employing the ETAR has increased the fun for students to learn English. Second, students look forward to oral English classes and are more willing to learn English actively outside class such as watching English audio and video programs. In addition, the result in the communication aspect is averagely significant. For instance, via the interaction with the ETAR, students found that they have developed the interest to practice oral English with native English speakers or with their peers. Such changes are positive for students because, by practicing with each other or with native speakers, students can discover the strengths and weaknesses of others, and consequently correct their spoken English. Lastly, in the Future Imagination category, most respondents can imagine using English to pass exams, or in other professions or places in the future. Interestingly, they can imagine better about the relationship between learning English and their future development.

4.2 On-Site Teacher's Observations and Suggestions

The teacher on-site in the experiment group has provided the following observations about student changes. First, unlike the frequently serious or silent atmosphere in the classroom, when the teacher announced the ETAR project in class, most students were focused on the teacher's announcement instead of looking down to play with their own cellphones. Some subtle exciting noise or laughs could be noticed. The students looked more lively so this seemed to show that they expected highly to see the robot. Second, in the freshman English class, students sometimes felt bored with the unified textbook [7]. In particular, when students practiced English conversations in the textbook, even though their answers were correct, they often spoke in a low voice, feeling unconfident and shy. However, after the ETAR-assisted vocabulary/text reading aloud, and conversation exercises, students could speak louder with better pronunciation and answer the instructor's questions with more confidence or energy. Third, students looked a bit nervous when they first met the ETAR–NAO–in this experiment, but towards the middle of the experiment, some students could make jokes with the ETAR and their peers in simple oral English. It further supported that the ETAR did create a fun, relaxing learning class and led to an increase in students' learning interest.

Nevertheless, the teacher suggested that on the one hand, to facilitate an experiment with a rather expensive ETAR, the required facilities such as an appropriate podium for the robot to sing or perform, and a multi-media classroom should be prepared in advance; on the other hand, as some participants were confused by the ETAR's touch spots like "my forehead" or "the front of my head", the overall ETAR functions and specific touch spots for robotic movements should be introduced and explained to participants before the experiment started.

5 Conclusions and Future Works

This study proposed an educational robotic system, ETAR, which was applied in a Freshman English class. Through the interaction between the students and the robot, students' motivation is increased and their oral English ability is also improved. Moreover, the class teacher was delighted to adopt the new unconventional teaching method and surprisingly notice a positive classroom atmosphere. This paper concludes with two major findings.

- The ETAR improves English learning motivation in class.

Regarding motivation, using the ETAR in the freshman English class has indeed contributed to the increase in students' English learning motivation. In particular, after four weeks of interaction with the ETAR, students' willingness to practice oral English with foreigners or peers is more intensified; moreover, they feel more comfortable communicating with others in English.

- The ETAR brings convenience to classroom teaching for English teachers.

Fixed teaching materials are often used in large classes, and most of these materials are taught by teachers with methods like group exercises, or teacher-student in-class questions and answers; therefore, innovative elements are needed to enhance students' learning interest and motivation. Even though some lectures are coupled with innovative teaching methods, if the novel technology with less cost spending can be integrated into the learning environment, students' learning interest can be increased. In addition, using robots as a tool for teaching assistance promotes closer and more stimulating interaction between teachers and students while at the same time, decreasing students' fear of learning, and teachers' tension of teaching oral English. In addition, using the ETAR helps teachers reduce routine and mechanical work such as calling students' names, pronouncing vocabulary, reading aloud texts and so on. With less lecturing workload and lower physical tension, teachers can save more time and have more energy to focus on the individual learners who are in need.

Despite the benefits mentioned above, the ETAR is not without its limitation and its system can be further developed in the following three directions in the future:

- The system can be applied to different types of robots and operations.
- Robots which teachers can easily design course contents with and operate can be developed.
- Field experiments of learning effects of younger students with the ETAR's assistance can be explored.

Acknowledgment. The authors would like to thank the Ministry of Science and Technology, Taiwan, R.O.C. for the financial support under the Grant numbers MOST106-2511-S-035-003-MY2 and MOST108-2511-H-035-002-MY2.

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Engaging Students in a Flipped English Classroom by Conducting an Interactive Response System and Its Effects on Students' Learning Achievement and Learning Motivation

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Abstract. In recent years, the flipped classroom has been widely adopted. It is a student-centered learning model that has been acknowledged in the literatures. However, students' engagements in the in-class activities of flipped classrooms will affect their overall learning performance. Especially, EFL learners tend to be inactive in English class. It is important for teachers to provide interactive learning activities and get instant feedbacks from the students to keep them engaged in class. Interactive Response Systems (IRS) provides the opportunities for students to interact positively with the teacher. They also allow the teacher to know better of student's individual learning situation. In this paper, an IRS was conducted in the in-class learning activities of a flipped English classroom. A quasi-experiment was conducted in a primary school in Taiwan to explore the effects of this approach on students' learning achievement and learning motivation. The experimental results indicate that conducting IRS in flipped English classrooms could significantly improve students' learning achievement, but the students' learning motivation was not dramatically promoted.

Keywords: Flipped classroom · Flipped learning · Interactive Response Systems · IRS

1 Introduction

English is the most popular international language in the world [1], which is an important tool for international communication. More and more people have been studying hard and trying to master English skills. In Taiwan, English is often taught as a second language [2]. English as a foreign language/second language (EFL) learner has fewer opportunities to practice their language skills compared to native language learners [3, 4]. Teachers' lectures occupy most of the class time, so that students lack

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 87–96, 2019.
https://doi.org/10.1007/978-3-030-35343-8_10

the opportunity to practice language, which leads students to lose interest in English learning and reduce learning motivation.

Due to social changes and technological development, teachers are allowed to use new methods to educate students. The flipped classroom is a student-centered mode that has been widely adopted in recent years. It is an innovative teaching mode that overturns traditional teaching and learning methods [5, 6]. It provides a more interactive learning environment for the classroom [7]. When the flipped classroom is implemented, there is more time in the classroom, providing opportunities for interaction, production, discussion and other activities [8].

In a flipped classroom, although the students play the leading role in learning, and teachers must clearly understand the students' current learning status so as to provide personalized guidance and adjust teaching strategies. However, in the traditional classroom response mode, students' participation is limited [9]. It only gives limited students the opportunity to answer questions at the same time. In addition, when students raise their hands to answer questions or give wrong answers, students may laugh at them and have a negative impact on their willingness to participate [10]. Therefore, in the flipping classroom activities, how to mobilize students to participate in teaching activities, positive thinking and interaction, and actively complete the construction has become a very important task in English teaching.

Interactive Response System (IRS) allows all students to answer all questions at the same time. It provides opportunities for students to interact actively with teachers. IRS can create a pleasant and positive classroom atmosphere [11], which can effectively stimulate students' motivation in the classroom [12] and promote deeper interaction between teachers and students [13, 14].

Therefore, in this study, an IRS was conducted in flipped English classrooms in a primary school to explore whether it would be helpful for students' learning achievement and learning motivation.

Based on the above research objectives, this study aimed to verify the following two research hypothesis:

(1) Conducting IRS with the flipped English classroom will benefit on students' learning achievement.
(2) Conducting IRS with the flipped English classroom will benefit on students' learning motivation.

2 Literature Review

2.1 Flipped Classrooms

The flipped classroom is a flexible teaching mode [15]. In this teaching model, students learn the learning materials prepared by the teacher before class, practice or participate in class discussions or other activities under the guidance and support of the teacher [16]. Students are given a higher degree of freedom in the learning process [7], and can flexibly arrange the pre-class learning schedule according to their own learning ability, learning time and other personal conditions [17].

Studies have found that students are generally satisfied with the learning mode of flipped classroom and believe that flipped learning provides beneficial learning experience [18]. Teachers can have more opportunities to guide students to apply what they have learned to practice, and provide necessary support for individual students in class [19]. The flipped classroom can provide more opportunities for cooperative learning and peer learning in class [20, 21]. Therefore, it increases the interaction between teachers and students, and promotes the participation of learners [22]. This way of learning allows students to spend more time practicing with their peers and teachers. It is obviously very suitable for English learning, because the teacher-supported exercises and the interaction with the peer are important for language learning.

Previous research has elaborated on the design of the flip classroom and tried to apply the flip classroom to English teaching. Studies have shown that the benefits of using flipped classroom in English teaching are mainly reflected in four aspects: learning independently, advance student preparation, overcoming the limitations of class time, and increasing the participation in the classroom [23]. Another research proposed a flipped contextual game-based learning approach. Compared with conventional game-based learning, the flipped contextual game-based learning can improve students' English writing ability with fewer writing errors [24].

However, some researchers pointed out that in the process of flipped learning, if teachers are unable to observe the learning status of individual students and timely feedback to them, especially in the case of large class size, the participation and learning achievement of students might not be as expected [25]. Therefore, it is very important to conduct effective learning technology tools into flipped classrooms, to support the development of teacher activities, to meet the needs of teachers to observe the learning status of individual students, and to provide real-time feedback, so as to improve students' learning performance and motivation.

2.2 Interactive Response Systems

The Interactive Response System (IRS) is a widely used tool in school that allows students to respond instantly and increase their participation in the classroom [26]. Through real-time feedback from IRS, teachers have more opportunities to manage courses [27], and students have the opportunity to control their level of learning [28]. IRS allows all students to answer all questions, to provide feedback to each student in real time, and to keep students active in the classroom [29]. It can be seen that the IRS not only allows students to answer questions or share their opinions through voting, but also allows teachers to understand the learning situation of the class and individual students.

IRS has been used in math, physics, art and other courses, including English courses. IRS can improve students' participation in classrooms and the accuracy of their answers, so teachers should focus on designing high-quality question-and-answer sessions to increase student engagement [30]. In second language learning, students often have strong nervousness and anxiety and are afraid or unwilling to speak. When students raise their hands to give wrong answers, classmates may laugh at them and have a negative impact on their willingness to participate [10]. Therefore, it is necessary to apply IRS to the classroom to increase students' participation in class, so as to improve their learning performance and learning motivation.

This study intends to conduct an IRS with flipped English classrooms, and use the instant feedback and interaction of IRS to enhance the concentration of students' class learning. When teachers can immediately understand the feedback information, they will be able to make properly adjustments to the student's learning activities. The flexibility of the adjustment makes the teaching of the flipped classrooms more effective, hoping to improve students' learning achievement and learning motivation.

3 Method

In order to evaluate the impact of IRS conducted in the flipped English classroom on students' English learning performance and learning motivation, a quasi-experiment was conducted on an elementary school English class to compare the students' learning achievements and learning motivations. The selected subject unit was the fifth-grade English "Time and Daily Activities".

The IRS system used in this study is Zuvio. Teachers can quickly collect student opinions and answers and understand their learning status in real time.

3.1 Participants

The participants of this study included three classes of fifth graders (26 students from each class). These three classes of students were randomly assigned to one experimental group and two control groups. The experimental group was guided by the approach of conducting IRS into the flipped classroom. Control group 1 was taught with the conventional flipped learning approach, while the students in control group 2 learned with the conventional teaching approach. The students in the three groups were taught by the same teacher.

3.2 Experimental Process

Figure 1 shows the four-week experimental procedure. During the 3-week experimental process, there were two sessions each week. In the first week, the students in the three groups took the pre-test to evaluate their basic knowledge level and completed the learning motivation pre-questionnaire. Following that, the students of the experimental group and control group 1 were given instruction about the flipped class, and the experimental group students were given explanation of the operation of the IRS to avoid the impact of system operation problems on the student learning process and effectiveness.

During the experiment, the experimental group and the control group 1 were scheduled to watch instructional videos in the morning self-study English class time (by English learning website), and then they wrote down key points or doubts to facilitate class discussion, as shown in Fig. 2. At the beginning of class learning, students in the experimental group were given a pre-class test through the IRS, so that teachers could learn about their pre-class learning. Then, the exercises and problems

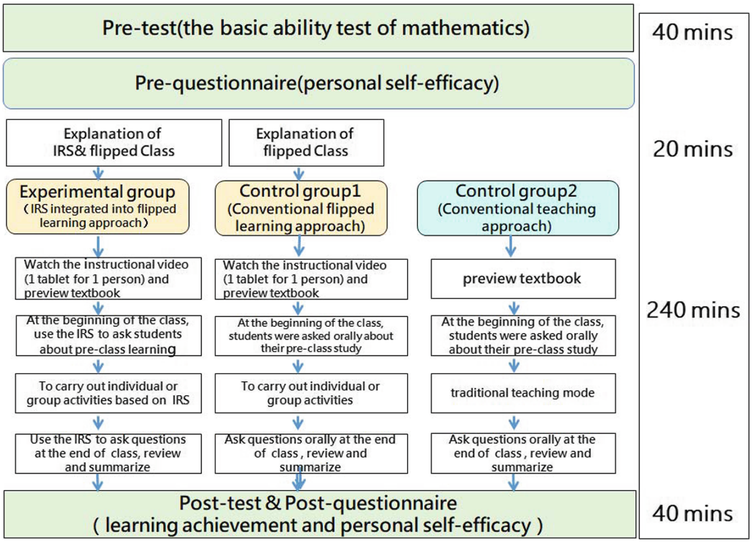

Fig. 1. Experimental design of the learning activities

were assigned through IRS in the class with the assistance of the teachers and their peers, and the activities were performed by personal operations, group discussions, etc., as shown in Fig. 3. At the end of the class, the teacher used the IRS to check the students' understanding of the course content.

Fig. 2. Watched online lectures

Fig. 3. Answered questions with IRS

On the other hand, the students in control group 1 were asked orally about their pre-class study, and were then asked to do individual practice, and take part in group discussion and other activities in class. Finally, the teacher checked the students' understanding of the course content by asking questions orally. During the experiment, the control group 2 were scheduled to prepare the English textbooks and write the exercises, and were taught by the traditional teaching method. Moreover, they were asked to do the exercises and homework after the class.

The three groups were given identical learning content in the learning activities and identical learning time, accounting for a total of 240 min during a 3-week period. After the learning activity, the students took the post-test and completed the post-questionnaires of learning motivation.

3.3 Measuring Tools

The pre-test and post-test of this study were jointly developed by experienced teachers in the school. The pre-test aimed to evaluate whether the three groups of students had equivalent prior knowledge of "time and daily activities". On the other hand, the questionnaire of learning motivation was modified from the measurement developed by Wang and Chen [31] based on the measure proposed by Pintrich, Smith, Garcia, and McKeachie [32]. It consisted of six items with a five-point Likert scale. The Cronbach's alpha value of the questionnaire was .92, implying that the questionnaire is reliable.

4 Experimental Results

In order to analyze the effects of IRS when conducted in a flipped English classroom, students' learning achievement and learning motivation are evaluated in the experiment.

Before the experiment, ANOVA was performed on the pre-test scores and learning motivation of the students. The homogeneities of the regression coefficient were tested on the three groups' pre-test scores and learning motivation. They were confirmed with $F = 0.99$ ($p = 0.399 > 0.05$) and $F = 1.695$ ($p = 0.173 > 0.05$), respectively. According to the results, there were no significant differences in the pre-test scores and learning motivation of the three groups, which indicated that the three groups of students had similar English proficiency and learning motivation before the treatment.

4.1 Learning Achievement

Within one week after the experiment, three groups of learners were post-tested. The analysis results are shown in Table 1.

Table 1. Results of one-way ANCOVA on students' learning achievement.

Group	*N*	*Mean*	*SD*	Adjusted *Mean*	*F*	Post hoc
(1) Experimental group	26	93.62	7.16	91.51	7.776^{***}	(1) > (2)
(2) Control group 1	26	84.31	20.66	83.72		(1) > (3)
(3) Control group 2	26	76.69	22.73	79.86		(2) > (3)

$^{***}p < .001$

According to the analysis results in Table 1, there were significant differences in the learning achievements of the three groups ($p = 0.046 < 0.05$). The Post hoc shows that experimental group was significantly better than control group 1 and control group 2, and control group 1 was significantly better than control group 2. That means both the flipped English classrooms are superior to the traditional English teaching in term of learning achievement, no matter IRS was conducted or not. Moreover, while IRS was conducted in the flipped English classroom, students' learning achievement can be further improved. The experimental results support the hypothesis that IRS will benefit students' learning achievement in the flipped English classroom.

4.2 Learning Motivation

Within one week after the experiment, the motivation of the three groups of students was investigated. The analysis results are shown in Table 2.

Table 2. Results of one-way ANCOVA on students' learning motivation.

Group	*N*	Mean	SD	Adjusted Mean	*F*	Post hoc
(1) Experimental group	26	4.21	0.58	4.18	6.62^{***}	(1) > (3) (2) > (3)
(2) Control group 1	26	3.90	0.51	3.88		
(3) Control group 2	26	3.48	0.66	3.54		

$^{***}p < .001$

Table 2 shows that there were significant differences in the three groups ($p = 0.046 < 0.05$). The Post hoc shows that Experimental group was significantly better than control group 2, and control group 1 was also significantly better than control group 2. That means both the flipped English classrooms are superior to the traditional English teaching in term of learning achievement, no matter IRS was conducted or not. However, while IRS was conducted in the flipped English classroom, students' learning motivation is not significantly improved. The experimental results do not support the hypothesis that IRS will benefit students' learning motivation in the flipped English classroom.

5 Discussion and Conclusions

In this study, IRS was conducted in a flipped English classroom for a primary school. Three phenomena can be observed from the experimental results:

(1) Students' learning achievement is improved in flipped English classrooms. That is consistent with most of the results from previous studies [33].
(2) While IRS was conducted in a flipped English classroom, students' learning achievement can be further improved. IRS promotes the participation of students and increases positive interactions between teachers and students in class;

students' learning experience is improved [29]. That could be the reason why students' learning achievement is further improved.

(3) Students' learning motivation is improved in flipped English classrooms. However, students' learning motivation is not further enhanced while IRS was conducted. In a flipped classroom, students can adjust their learning progress and learning rhythm in their pre-class self-study. These freedoms can increase their intrinsic motivation [34]. That is, self-directed learning and learner control can influence motivation [35]. That leads a hint that while IRS is conducted in-class, teachers should flexibly adjust the rhythm of the lectures based on feedback collected by students using the IRS [12] to further enhance students' learning motivation.

The major contribution of this study lies in the outcome of conducting IRS in a flipped English classroom, which can significantly improve students' learning achievements. Although it does not significantly enhance students' learning motivation, it also provides a direction for future research.

However, current research still has some limitations. The small sample size and the limitations of specific disciplines may limit the promotion of these results. In the future, the scale of the experiment will be expanded. The sample size will be enlarged and the experiment time will be lengthened. Moreover, more factors, such as flow experience and cognitive load, can be taken into account in future research.

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Visual Attention Analysis During Program Debugging Using Virtual Reality Eye Tracker

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Abstract. The immersion of virtual reality (VR) has transcended the existing experience of multimedia teaching. This paper aims to design a virtual reality eye tracker device to analyze the cognitive process of program debugging by adopting virtual reality technology to build a 3D code rendering system and, at the same time, using eye tracking technology to study visual attention as well as to analyze and compare the differences in internal behavioral cognition in terms of program debugging. This paper has 32 students as participants who have studied C++ programming language courses for more than one year in the department of computer science. With Unity 3D development tool, the experiment creates a virtual classroom scene and C++ programming language code. The participants' eye movements are recorded by an eye tracker device integrated in a Head-Mounted Display (HMD). The eye movement defines the regions of interest (ROIs) according to the division of the program's function, and the difference in visual attention between various ROIs in the code is discussed when the participant performs the program debugging task. The finding results are expected to improve the dilemma of the existing programming teaching, so that the instructors can provide appropriate teaching aids for students to achieve the purpose of programming teaching and improving the students' programming competence.

Keywords: Virtual reality · Eye movement analysis · Program debugging · Visual behavior

1 Introduction

VR technology mainly presents instant, dynamic and interactive scenes, which can simulate scenes that cannot be operated or observed in a real-life teaching environment, so as to bridge the differences in user perception and, by means of adopting appropriate

The original version of this chapter was revised: the affiliation of the authors listed the incorrect country. This was corrected. The correction to this chapter is available at https://doi.org/10.1007/978-3-030-35343-8_90

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 97–106, 2019.
https://doi.org/10.1007/978-3-030-35343-8_11

software and hardware interfaces, to enable users to interact with virtual contexts and acquire more specific learning experiences to enhance learning interest and effectiveness. For example, [1] use VR to build an "active virtual ergonomics learning system" that allows learners to observe 3D virtual human organs through this system to understand the functions, ways of operation, structures, and locations of the human organs.

This paper developed a VR eye tracker, and aims to integrate eye tracking technology into VR technology. Through the presentation of VR 3D code, the interaction of different cognitive styles and gender differences through eye tracking technology is recorded. The point of observation that the participant focuses on in the VR context is also recorded to understand where the participant's attention is focused so as to explore the participant's perception ability to the program debugging task and obtain real-world feedback. In addition, according to the regions of interest (ROIs) defined in the code, the research analyzes and explores the different factors that can influence the visual behavior generated in the process of program debugging, in order to obtain more accurate and objective data to complement the lack of relevant research existing in the field of program debugging.

Program debugging is an important basic skill in the programming process. Many scholars have explored and confirmed the factors affecting the effectiveness of program debugging, by means of comparing the differences between experts and beginners [2, 3]. In addition, in order to further explore the implicit behavior of program debugging, many researchers have conducted relevant studies in the field of cognition [2, 4]. It is found that program debugging is highly relevant to the operation of the cognitive process [4]. For example, [5] pointed out in their research that debugging and understanding a program are the basic skills that programmers need in order to edit programs, and the skills are executed in a complex cognitive process [2, 6], and this complex cognitive process signifies that learning a program language will increase the cognitive load of students.

[7] argued that more than 80% of the information in the human cognitive process is made by vision and such information is a very important driver for the brain when humans think. Therefore, the study of eye movement is considered to be the most effective means of visual information processing and is also a multifunctional cognitive comprehension tool that enables researchers to track human eye movements for deeper cognitive processes [8, 9]. In other words, through eye tracking technology, researchers can understand the knowledge processing of learners during the learning process [9–11], and, in a more natural and instant way, researchers can further explore human cognitive thinking [12] which allows the conducting of experiment in the most natural state [13] while minimizing the factor of interference. Therefore, the purpose of this paper is to design a series of 3D code and answer questions using VR technology through the self-developed VR eye tracker. Based on the purposes above, the paper hopes to answer the following questions:

1. Does the visual attention of the participant exhibit any difference when the program is debugged? If so, what is the difference?
2. Is there a difference in the correct answer rate of the participant when the program is debugged?

2 Related Work

2.1 Applications of Virtual Reality in Education

The virtual reality system can make learners immerse themselves in the learning environment and this immersive experience, along with other interactive features, enhances the interaction between learners and materials, transcending the constraints of time and space and providing an opportunity for learners to practice repeatedly. If VR can be added to traditional teaching activities, it can certainly provide learners with a more realistic and flexible learning environment. In general, VR applications in education can be divided into three major categories, i.e. education, training, and performance support. First, education refers to the transfer of knowledge, including school education and workplace education. For example, medical education emphasizes time saving, cost reduction, and collaborative work. In this sense, [14] used VR to create an interactive and integrated online virtual human anatomy teaching system to improve the teaching of ergonomics. [15] applied a VR technology to create a teaching system called "Anatomic VisualizeR" to assist the teaching of clinical anatomy. [16] argued that VR can simulate the spatial relationship of human body structure and designed a web-based virtual system of human body structure to assist the teaching of human anatomy. Second, training refers to competence or skill training, which can take place in either schools or workplaces.

2.2 Research on Eye Tracking Technology and Program Debugging

[17] was the first researchers to use eye tracking technology to analyze the understanding and reading of programs. They explored the relationship between cognitive styles, individual differences, and code reading patterns, and tried to find out whether different participant groups (experts vs. students) exhibited different eye tracking data as participants tried to make sense of the algorithm program. In terms of qualitative research on eye tracking technology applied to program debugging, [18] used eye movement information to define an eye movement mode called "Scan" to illustrate the participants' individual performance of source code reading. The results show that the longer a participant spends trying to locate the error, the faster the location of the error can be confirmed. [19] conducted a study of program debugging through the presentation of different variable naming schemes (i.e., Camel case and Underscore). The results show that if the participant spends more time scanning through the code, the faster the error can be located. [20], on the other hand, conducted programmatic grammar and semantic debugging through analyzing eye fixation and mouse cursor information. The study found that most students focused on semantic errors because they are more difficult than grammatical errors, and mouse cursor information can serve as additional data to complement eye fixation information.

Various researchers [21–23] have integrated programming software with eye trackers to find the differences in high- and low-achievers as they use editing software during program debugging and understanding, as well as the conversion between different regions (i.e. code display region, program category associated visualization region, output result display region, etc.), and the fixation counts (FCs) and fixation durations (FDs). The results show that, in terms of program debugging or program comprehension, low-achievers had significantly higher FCs and longer FDs in the program category associated visualization region, compared with high-achievers, while high-achievers (except in the program comprehension experiment) exhibited significantly better conversion skills among the three regions of interest (ROIs), compared with low-achievers. [24] solved the problem of insufficient samples, conducted a sequence analysis of the fixation data obtained to find out the correlation between ROIs, and then speculated the participants' cognitive processes during the tasks of program comprehension and debugging. The results show that low-achievers may suffer from the lack of sufficient working memory, which drives them to repeat certain calculation or noting tasks.

3 Research Methodology

This paper uses a self-developed VR eye tracker as the instrument to collect and record quantitative data of the participants' eye movement trajectory, and aims to explore the differences in the participants' visual attention under the immersive experience as they debug the program according to the data recorded by eye tracking technology.

3.1 Participants

The participants of the paper are male and female students who have learned C++ programming language for at least one year from a university's information department in southern Taiwan. A total of 32 students participated and were tested with the VR eye tracker program debugging task.

3.2 Stimuli

The paper uses Unity 3D development tool to design three VR program debugging questions. Each question contains one to three grammar or semantic errors. The participant needs to find the errors in the program without the help of program editing software, and then use the handheld controller to interact with the question. In order to prevent the participant from guessing the answer directly from the name of the variables, the variables are only named after simple symbols, and the regions of interest (ROIs) are divided according to the functions of the program [24], such as variable declaration, loop condition judgment formula, functional program operation, function call, etc. The definition of the ROIs is based on the recorded video output, and the ROIS are defined after the formal experiment. The Unity 3D development tool is used to design a virtual classroom scene and 3D rendering of the C++ source code. The red box represents the ROIs that need to be defined after the experiment and their names. In the question, the VR classroom scene is shown in Fig. 1, while Fig. 2 shows the ROIs defined in the first question. The header file is defined as ROI1. The variable declaration in the main program and input/output are defined as ROI2. The while loop is defined as ROI3, and the if/else conditional expression as ROI4.

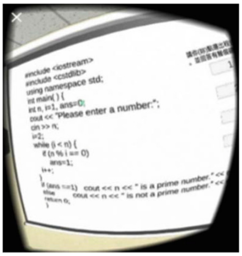

Fig. 1. The virtual scene of VR classroom

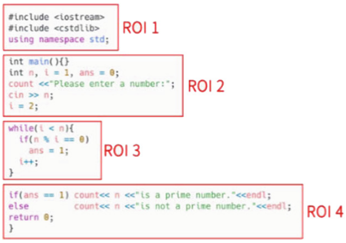

Fig. 2. The ROIs of the C++ program

3.3 Instruments

The research tool used in this paper is “VR eye tracker”, which has an extra mini microscope to record images/footages. The microscope is used especially for eye pupils and has an infrared LED light. The screen update rate is 30 frames per second. The microscope lens is integrated into the VR helmet and well-adjusted to make sure it can capture the pupil movement. In other words, it is a self-developed VR eye tracker as shown in Fig. 3. This VR eye tracker is compatible with computers that use Windows 7, 8, or 10. Before the VR eye tracker starts recording, a 5-point calibration must be performed so that the system can accurately record the eye trajectory. After the researcher assisted the participants to properly wear the VR eye tracker, the participants then engaged in the calibration under the researcher’s instructions and avoided moving their head as much as possible.

Fig. 3. VR eye tracker equipment

3.4 Data Output

In the course of the experiment, participants are required to view the C++ code via the VR device. In addition to recording the eye movement data with the built-in eye tracker, participants also need to use the handheld controller to click the answers. After viewing all the questions, the computer connected to the VR eye tracker (notebook or tablet) will automatically output the eye movement data of the participant. The output files are a video footage and a text file. The video footage (.wmv) is used to define the ROIs, and the text file (.txt) is the eye movement data.

3.5 Data Collection

After the experiment is completed, the eye movement data is organized and analyzed to explore the visual behavior and answers of the participants during VR program debugging, in order to verify the research questions. After collecting the eye movement data, the researcher used two auxiliary tools of the EyeNTNU_120 eye movement analysis software: VR dynamic ROIs tool and fixation calculator tool, to carry out the initial organization of the data. The VR dynamic ROIs tool mainly provides the definition of ROIs, and the fixation calculator tool can automatically process the prioritized ROI when the ROIs overlap with each other, which can avoid errors in data analysis.

3.6 Data Analysis

The research collects the participants' eye fixation information with the help of eye tracking instrument and eye movement visualization analysis software. The differences in visual attention and correct answer rate during the debugging task are analyzed and compared. Besides, the four common eye movement variables used in visual behavior analysis are the latency of first fixation (LFF), the duration of first fixation (DFF), the total fixation duration (TFD), and the fixation counts (FC) on each ROI.

According to the eye movement data collected by the VR eye tracker and the eye movement indicator visual analysis software tool, the paper aims to explore whether there is any difference in the participants' visual attention and the correct answer rate of the VR program. Thus, the research raises three hypotheses as follows:

Hypothesis 1 (H1): During the debugging task, the gaze sequence of participants was ROI1, ROI2, ROI3, and ROI4.
Hypothesis 2 (H2): During the debugging task, the relative order of the capacity of the types of ROI to hold the attention of the participants was ROI3, ROI4, ROI2, and ROI1.
Hypothesis 3 (H3): During the debugging task, different participants' TFD and FC exhibit significant differences.

At the end of each participant's experiment, participants are required to use the handheld controller to click on the answers to the questions asked as instructed. The correct answer rate is used as an indicator of debugging competence (correct answer *rate* = *number* of correct answers/number of questions). Each question represents a different degree of cognition when the program is debugged, and the participant's debugging competence is determined by his or her correct answer rate.

4 Results and Discussion

In this experiment, there were a total of 32 participants answering three VR program questions. At the end of the experiment, participants were asked if they had encountered any problems during the experiment. In order to gain a deeper understanding of the participants' condition during the experiment, the hot zone map and the trajectory map were used to view relevant changes. From the trajectory map of the question as shown in Fig. 4, it can be seen that the first point of fixation lies in the upper left corner in ROI1, and the fixation sequence started from the top left and then continued in a top-down fashion. First, LFF shows the type of ROI that attracts the visual attention of each participant. Thus, according to the results of Table 1, the mean of LFF showed that the participants' gaze in ascending order is ROI1, ROI2, ROI4, and ROI3. LFF showed that ROI1 captured the attention faster than the other types of ROIs. This is probably because the header area of the ROI1 is the first description area among all ROIs while coding C++ programs.

Fig. 4. Participants' scan path of first fixation

Table 1. Mean of LFF eye tracking data for each ROI (Unit: ms).

Nos.	ROI1	ROI2	ROI3	ROI4
32	20564.79	22622.08	31059.38	29448.55

DFF shows the capacities of all the types of ROI to hold attention of each participant. According to the results of Table 2, the mean of DFF in descending order is ROI1, ROI2, ROI3, and ROI4. The DFF is longest for ROI1. It could be argued that the ROI1 (the header area) is the first and foremost component in a C++ program. Therefore, ROI1 holds the attention of each participant for the longest duration while viewing a C++ program.

Table 2. Mean of DFF eye tracking data for each ROI (Unit: ms).

Nos.	ROI1	ROI2	ROI3	ROI4
32	359.61	320.38	298.25	173.27

This experiment requires the participants to identify the errors in the program. The program errors in the question lie in ROI2 and ROI3. In order to understand whether the participant will pay more attention to the problematic section, the total FD and FC of the ROIs in each question are further interpreted. The program errors in the question lie in ROI2 and ROI3, and it can be observed from Table 3 that the ROIs TFD and FC value of these two regions rank second highest and third highest respectively.

Table 3. TFD and FC eye tracking data for each ROI (Unit: ms)

Eye movement indicators	ROIs			
	ROI1	ROI2	ROI3	ROI4
TFD	404132	157972	127157	94712
FC	4200	1845	1622	1021

5 Conclusions

This paper uses VR technology to design a virtual classroom scene and 3D presentation of C++ source code. Integrated with the application of eye tracking technology, the research analyzes eye movement data and eye tracking information to explore the visual behavior of C++ source code in a VR classroom scene. Although VR and eye tracking are not innovative technologies, they can be integrated in a VR eye tracker device for viewing C++ source code in VR classroom scenarios. From the results of program debugging, there is no significant difference in the visual attention of participants. From the LFF table of the question as shown in Tables 1, it is found that the fixation sequence is mostly top to bottom during program debugging. Also, from the DFF of the question as shown in Tables 2, it is found that there will be longer FDs in the problematic program area. However, according to the feedback given by participants after the experiment, a small number of people had longer FDs on the question because they were still getting adapted to the equipment.

From the results of program debugging, it can be found from the FCs of the ROIs from Tables 3 that in the problematic code ROIs, there are more FCs, which means as the participant identifies a problematic code, the FCs at the region containing the problem is more. In conclusion, this pioneering research combines eye tracking technology and VR technology, yet its operation of eye tracking technology and data acquisition is limited by the equipment and influenced by the quality of the VR 360-degree scene. Hence, it is worthwhile to continue an in-depth exploration of the research goals and current results in the future.

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The Effects of Collaborative Learning on Students' English Learning Motivation and Style

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Abstract. The study focuses on the investigation of English as a foreign language (EFL) students' learning motivation and style. Moreover, the study highlights the usage of collaborative learning as the teaching strategy, which is different from traditional teaching method. Teacher made EFL students learn collaboratively to see if it could assist them to learn more efficiently. The study recruited 100 tenth-grade students in Kaohsiung City. They were sorted into two classes: one is the experimental class; the other is the control class. In the process of experiment, the English teacher asked the students in Experimental Class some questions based on the textbook content so that the students could conduct group discussions in each lesson of the semester. Regarding the Control Class, the English teacher guides the students to learn the content according to their textbooks, and doesn't give the students any group discussion questions. The results designate that students' English learning performance improved and their learning motivation and attitude heightened in the process of collaborative learning. Students have a high evaluation of collaborative learning because their burden in the learning process is reduced. What's more, they enjoy the fun of interacting with others.

Keywords: English as a foreign language · Collaborative learning · Learning motivation and attitude

1 Introduction

1.1 Background and Motivation

English is an international language, and it's a major medium for people from different countries to communicate with each other. Therefore, Taiwan government has taken key measures to promote English teaching to enhance its global competitivenesses. The General English Proficiency Test (GEPT) is used to test examinees' English mastery, and is one of the most important initiatives taken by the Ministry of Education (MOE). Another major step taken to achieve the government's goal of improving national

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 107–116, 2019.
https://doi.org/10.1007/978-3-030-35343-8_12

strength and wealth is that the Ministry of Education has enacted a new policy to implement English language instruction from the third grade in 2005, rather than starting from the fifth grade [1].

Since the 1950s, traditional teaching strategies have been led by teachers and have been the mainstream of Taiwanese English education [2]. In this environment, students sit in the front of the classroom, face blackboard, write down teacher's directions, and then inactively listen to teacher's courses, and there's almost no chance to interact with peers in class [3].

In recent years, many researches have demanded the advantages of collaborative learning (CL), which had been applied from pre-school education to higher education to university, in many fields such as language, science, and mathematics [2]. For the past twenty years, researchers such as Jules [4] and Slavin [5] have recommended cooperative learning (CL) as an efficient foreign language or second language teaching method. Applied CL teaching method, learners imitate group members and English teachers, combine language and text, and practice verbal or non-verbal English through interaction with teammates.

Despite the strong recommendation of scholars and researchers that CL is an efficient teaching strategy, a great number of college English professors still find it difficult to adopt this teaching method in the classroom [6]. The main reason for this may be that teachers are not familiar with CL's knowledge and skills, inappropriate grouping methods or learning activities [6]. The study attempts to find out viable and effective models that benefit instructors and students.

1.2 Purposes of the Study

The purpose of this study aims to investigate the influence of collaborative learning on high school students' English ability. This study evaluates students' English reading achievement and classroom interaction as the key to collaborative learning.

1.3 Research Questions

This study mainly explores the following research questions:

1. Do students like collaborative learning (CL) rather than traditional teaching (TT) in terms of the learning style in the classroom?
2. Does CL motivate students to perform better in their language learning as compared with TT?

1.4 Limitations of the Study

The main limitation of this study was the limited sample size of 100 students from two classes in the same school. Therefore, the results may not be extended to larger numbers of high school students. In addition, because of time and resource constraints, the level test at the end of the semester will be limited to written tests that focus only on the student's reading level, and not on verbal ability.

2 Literature Review

2.1 Traditional Teaching Approach in EFL

In the part, the discussion focuses on three main areas, including the characteristics, advantages and disadvantages of traditional teaching methods.

The Characteristics

Firstly, this is a labor-saving method since the instructor does all the work in the native language. Therefore, learners can understand courses in their native language without any difficulty and learners can get to the point immediately. Secondly, it symbolizes Deductive Approach. In other words, the teacher vividly explains the grammar rules and language content in the beginning, and then applies this knowledge to translate sentences into or from the foreign language. Thirdly, the teacher emphasizes reading and writing parts, paying little systematic attention on speaking and listening. Fourthly, the teacher illustrates the grammar patters and rules to help learners realize the reading content. In addition to grammar patterns, the teacher also illustrates the key vocabularies corresponding to the reading texts with their translation equivalents. Finally, learners' academic performance is the main concern when taking examinations. That is, the form of assessment is more standard and single.

The Advantages and Disadvantages

Grammar-Translation method and its modifications are diffusely applied in certain countries nowadays. Brown [7] explained some reasons for its popularity. First, teachers need less specialized skills. Second, grammatical tests can be constructed and scored more easily and objectively. However, many problems and disadvantages of the method were also argued by some researchers. Brown [7] mentioned that the Grammar-Translation method is not useful for enhancing students' language communication skills. For a great numbers of foreign school learners, they find it boring to acquire a language by means of the method because they have to memorize lots of new vocabularies and grammar rules so as to acquire the perfect translation of the reading texts. In addition, little advocate and related researches, like linguistics or educational theories, have been offered to verify the method and provide a theoretical basis [8].

As aforementioned, one of its major characteristics in the method is its focus on the unit of sentence. However, providing explanation of grammatical rules and some sentence example practices may not be served as a complete context for students to comprehend the definition and use of certain words or a sequence of words. Since there are not just sequences of sentences in naturally occurring language, language teaching focusing on sentences as the basic unit of language will fail [9]. Brown [7] also argue that even if the definition is supported by several exemplary sentences, the meaning of the word cannot be captured by definition. The Grammar-Translation method also emphasizes the translation task. Coulmas [10] argued that semantic translation cannot ensure the functional equivalence or correspondence in the target language since some lexical items have the feature of idiomaticity. This kind of interferential mistakes may cause the misunderstanding of meaning and in turn hinder the communication.

In summary, the traditional method is also adapted or recommended by a great number of EFL language instructors because it helps teachers with lower professional skills, and prepares for easy-to-build exams. However, this method implies theoretical deficiencies and is inconsistent with the nature of language use. As a result, probing other teaching approaches that are more beneficial to students' language learning with natural environment is essential. In view of this, in this study, Student-based Group Discussion is recommended as a better teaching and learning approach.

2.2 Cooperative Learning Theory

Recently, collaborative learning is extensively used in ESL/EFL learning [11–13]. Most studies have supported ESL/EFL learning with high satisfaction. Olsen [11] mentioned a few researches corresponding to collaborative learning. Comments show that non-native English speakers have more language requirements and academic accomplishment in collaborative learning programs than traditional full-class teaching. In addition, rich interaction between students in cooperative classes helps students to understand their meanings, explain them carefully, resolve differences, and ultimately advance understanding of text materials. Even when interacting with each other, students can use the target language much more often, which is difficult to achieve in the traditional whole class teaching.

Teachers' Role in Cooperative Learning

Chen [14] describes the role of teacher in cooperative learning classroom as an investigator, a creator, an examiner, and a facilitator. That means the role of the teacher has shifted from a sole authority of knowledge to an organizer of courses, guide, facilitator, and evaluator. The center of learning as shifted from teachers to learners. However, that doesn't mean the teacher becomes unimportant. Teachers in cooperative classes take even greater responsibility than those in traditional classrooms. In the beginning, teachers have to assign students into groups homogenously or heterologous to achieve the greatest learning effect. Then, they still have to give some necessary lectures. During the process of group work, they have to monitor the process and give necessary aid in time. Since the process of cooperative learning is very important, process evaluation is adopted in cooperative learning. Teachers can take care of the individual differences of students by observing them when group activities are progressing, and give immediate help when necessary.

Students' Roles in Cooperative Learning

In cooperative learning classrooms, learners have to actively participate in the teaching activities. The teacher is no longer the center in teaching. The students have to collect some data for the group learning. They may collect certain pictures, articles or even some realia to share with their group members. Besides, since teachers' lectures have been greatly reduced, the students have to discuss with each other and give their own contribution to the whole group and make sure each member in the group has understood the learning materials. As for evaluation, the students have to take some responsibility of evaluating their peers. In other words, students have become the center of learning.

3 Method

3.1 Participants

The study recruited 100 tenth-grade students in Kaohsiung City. 50 are boys and 50 are girls. The 100 students were sorted into two classes: one is the experimental class; the other is the control class. The instructor in both classes was the conductor in this study. The teaching procedure for both classes in this study was completed in one semester, and two hours of classroom teaching would be conducted every week.

In the process of experiment, the English teacher asked the students in Experimental Class some questions based on the textbook content so that the students could conduct group discussions in each lesson of the semester. Regarding the Control Class, the English teacher guides the students to learn the content according to their textbooks, and didn't give the students any group discussion questions.

3.2 Tools

The tools used in this study included test sheets, the questionnaire, and Windows SPSS (as a statistical tool for data analysis).

3.3 Data Collection and Analysis

The data will include responses from teachers and students to the questionnaire and academic performance of students' taking the final accessment at the end of the semester. Besides, quantitative analysis of the answers to the questionnaire and test grades of the accessment will be conducted.

3.4 Flowchart of the Procedures of the Study

See Fig. 1.

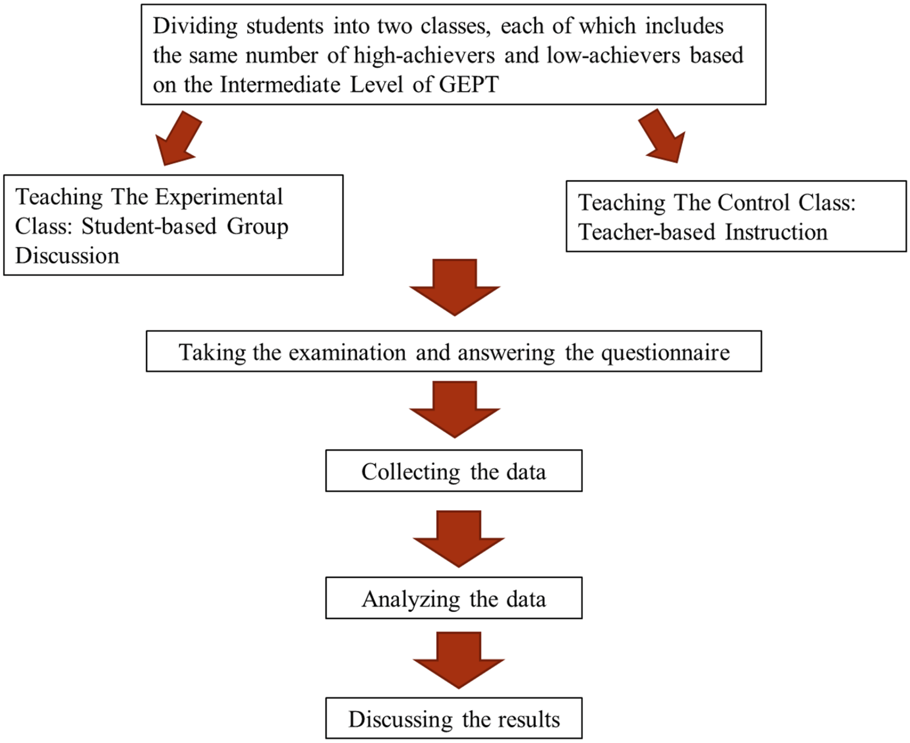

Fig. 1. Flowchart of the procedures of the study.

4 Results and Discussion

4.1 Impact on Students' Preference of the English Learning Style of Cooperative Learning and Traditional Teaching

Q1. Does CL motivate students to perform better in their language learning as compared with TT?

As seen in Table 1, the pre-treatment students' English proficiency statistics showed that the difference in pretest scores between experimental group and control group did not reach a significant level ($t = -1.034$, $p = .258$). Consequently, it declaims that the two groups are homogeneous.

Table 1. An independent sample test analysis summary comparing the pre-test scores of students' academic performance the Experimental Group and the Control Group.

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	50	63.055	15.573	−1.034	0.258
Control group	50	67.502	12.122		

$P > .05$

In fact, it can be even implied that before the implementation of treatment, in terms of CL and TT, students may not prefer any way of learning. However, for the purpose of discussing whether students prefer CL rather than TT after treatment, data on cooperative learning attitudes collected from the 25 chosen response items (Part 2) of the questionnaire were analyzed by independent samples. The test was conducted between experimental group and control group, and the paired sample test was performed in experimental group.

Table 2. Independent sample test analysis and comparison of English learning style preferences of experimental and control students by post-treatment questionnaire.

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	50	85.620	11.610	4.635	.000
Control group	50	72.589	9.276		

$^{*}p < .05$

In Table 2, the analysis data from the second part of the post-treatment questionnaire showed that it reached a significant difference ($t = 4.635$, $p = .000$) in English learning style preferences between experimental groups ($M = 85.62$, $SD = 11.61$) and control group ($M = 73.69$, $SD = 9.38$). That is, it dedicates that experimental group members have a significantly greater preference for CL than homogeneous students in control group. It is the same when we specifically consider students who complete treatment (CL) in experimental group.

Table 3. Paired sample test analysis of English learning style attitude before and after treatment in the Experimental group ($N = 58$).

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	Before	88.761	5.254	2.150	.013
Control group	After	91.527	11.812		

$^{*}p < .05$

According to Table 3, data analysis from the second part of the same questionnaire showed that the attitude or preference of experimental group for English learning mode (CL) shifted from pre-treatment 88.761 and SD 5.254 to pre-treatment levels. The mean after treatment was 91.527 and the *SD* was 11.812 ($t = 2.150$, $p = .013$). Therefore, in the post-treatment study, the attitude toward CL or the preference for CL as an English learning style, students in experimental group expressed great changes in their views. The students in experimental group showed positive attitudes toward or value more highly of studying English through CL. In fact, this collaborative learning approach not only enhances their interest in EFL learning, but also enhances their achievements, which can be found in the answers to Research Questions 2 and 3 in Sects. 4.2 and 4.3 respectively.

4.2 The Impact of Cooperative Learning (CL) on Students' Enthusiasm for Learning Language

Q2. Does CL motivate students to perform better in their language learning as compared with TT?

Table 4. Analytical summary of Independent Sample tests for comparing pre-motivation scores of students in pre-treatment in experimental and control groups

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	50	35.086	3.508	.673	.583
Control group	50	35.733	4.013		

$P > .05$

In Table 4, the comparison of English pre-learning motivations between the two groups showed that the students' pre-English motivation scores ($t = .673$, $p = .583 > .05$) did not reach the significance level. As a result, this shows that there's no significant difference in English learning motivation between Control group and Experimental group before the treatment being performed in former group.

We can deduce that most of the students in Experimental and Control groups have similar motivations to learn English before treatment. However, Table 4 shows a comparison of post-motivation between the two groups.

Table 5. Independent sample test analysis and comparison of post-exercise results between experimental group and control group after treatment.

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	50	42.672	1.693	5.705	.000
Control group	50	31.544	2.430		

$^{*}p < .05$

According to Table 5, the average post-motivation score of Experimental group was 42.672, and the standard deviation was 1.693. The average post-motivation score of Control group was 31.544, and the standard deviation was 2.43. In addition, the comparative statistics of the same questionnaire after the experiment showed that the difference between Experimental group and Control group in English learning motivation indeed reached a significant difference ($t = 5.705$, $p = .000 < .05$). Distinctly, compared with Control group, the members in Experimental group scored much higher on the motivation of English learning in the first part of the same questionnaire. Therefore, it turns out that the impact of CL on the members in Experimental group is remarkably better than that on the members in Control group as for students' English learning motivation.

4.3 Conclusion of Section 4

After the treatment, the motivation of English learning in the experimental group changed a lot. Besides, students' learning motivation in Control group decreased significantly. Subjects see CL as a better way to learn and collaborate with team members so they can help each other and develop personal responsibility.

5 Conclusions and Suggestion

5.1 Summary of Key Findings and Results

The purpose of this study is to understand the impact of CL students in the EFL classroom. The study found that CL could effectively improve students' English learning scores, and could also enhance students' motivation for English learning. In addition, students generally believe that this is a creative and fun learning style for CL teaching methods. This learning process can reduce students' learning pressure and make students more willing to work between peers. However, students in Experimental group and Control group did not have significant differences in learning motivation before the start of the experiment. But the differences in learning motivation before and after the experiment were greatly higher in the CL group than in the TT control group.

The experimental results revealed that the students in the control group who took the TT had lower motivations for English learning; on the contrary, the students in Experimental group who took the CL made great improvement in the motivation for English learning. The main factor is that students who took the CL formed a clase relationship with each other, so that they got more encouragement and motivation to learn.

Based on the concept of collaborative learning [15], this study found that members of the study group can work together for a common goal; and they all recognize that they must work for the study group. They recognize that the process of English learning is no longer just a manifestation of personal achievement, but also a sense of accomplishment based on group honor.

5.2 Teaching Significance

The purpose of this experimental study is to understand more effective ways to teach English in Taiwan. The results of this study can provide a cooperative learning teaching thinking in English teaching in higher education, and encourage teachers to be more courageous to create a cooperative learning style English teaching environment. It allows students to guide, cooperate and encourage each other through peer education.

Although this research and related literature support CL teaching methods, students' learning can have positive effects in terms of learning motivation or learning achievement. However, for Taiwanese teachers, in the preparation of English teaching and the actual teaching process, if you want to adopt the CL teaching method, you still have to master the CL's important teaching skills by participating in more training courses. The personal standard TT teaching style has gradually transformed into a cooperative learning style of cooperation and team-oriented.

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The Designing of Constructivist Web-Based Learning Environment to Enhance Problem Solving Process and Transfer of Learning for Computer Education Student

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Abstract. The purpose of this research was to design and development of constructivist web-based learning environment to enhance problem solving process and transfer of learning for computer education student. The developmental research (Type I): design and development process were employed in this study. Several methods used were document analysis, survey and case study. The results revealed that: (1) The designing of constructivist web-based learning environment consisted of the following components; (1) Problem base (2) Resources (3) Cognitive tool (4) Collaboration (5) Related case (6) Fostering problem solving process center (7) Transfer of learning center (8) Social support for education views (9) Scaffolding, and (10) Coaching, (2) The efficiency of this learning environment was evaluated by expert review. It was found that the learning environment is appropriate on 3 aspects: content, instructional design and media. (3) The problem solving process was found from the problem solving process test form (*mean* = 86.54, *S.D* = 0.31) and the transfer of learning test form (*mean* = 81.22, *S.D.* = 0.21) that every learner passes the 70% criterion of the specific scores, and (4) The students' opinion towards the learning environment was divided into 3 aspects. They were (1) the contents can be supported concept formation of the learners, (2) characteristic of learning environment was designed for helping learners to easily for learning about in classroom and out of the classroom, (3) the learning environment supported and encouraging learners to enhancing knowledge construction and problem solving process and transfer of learning for the learners.

Keywords: Constructivist learning environment · Problem solving process · Transfer of learning · Web-based learning environment

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 117–126, 2019.
https://doi.org/10.1007/978-3-030-35343-8_13

1 Introduction

21st century skills consist wide range of skills and abilities that are necessary for success in a technological world [1]. 21st century skills promote lifelong learning, which allows students to adapt and be more responsive as the world around them changes and as they, themselves grow and change [2]. Problem-based learning (PBL) is perhaps the most innovative pedagogical method ever implemented in education. Its effectiveness in facilitating student problem-solving and self-directed learning skills has been widely reported in higher education [3, 4]. Problem solving process and transfer of learning will help us to resolve problems in not only academic life but in all parts of the life. Researchers and educators need more information about problem solving process and transfer of learning to help their students more efficiently. If problem solving process is a cognitive activity then, improving problem solving process and transfer of learning through education should be a valuable goal [5].

In addition, problem solving process is highly student-centered and involves students developing their own knowledge and discovering important information through teacher guidance, not teacher lecture. Therefore, problem solving process is fundamentally different from teacher-centered approaches that involve teachers simply giving students the information they need to know.

Especially in Design computer learning management in secondary school courses for basic education which students must study the theories, principles, and practices regarding learning management design, a learning management method, development of appropriate media or learning innovation, including actual measurement and evaluation that is consistent with the learning management methods of each subject that is used to manage learning in the classroom. And experimentation in the classroom to assess to improve the method of learning management with complex content characteristics (Ill-Structured).

The reasons mentioned above, this study recognize the importance of constructivist learning environment design. The researcher synthesised the designing framework of a constructivist learning environment based on principles, constructivist theory, problem solving, and transfer of learning, the media attribution and symbols system used, web-based learning design and the specific context for the learning content synthesizing them as the framework for designing the constructivist web-based learning environment. The results of this study have confirmed that the learners appreciated the design for enhancing problem solving, and transfer of learning involved in the constructivist web-based learning environment.

2 Literature Review

2.1 Constructivist Learning Environment

Constructivist conceptions of learning assume that knowledge is individually constructed and socially co-constructed by learners based on their interactions in the world. The meaning that learners construct depends on their needs, beliefs, and prior knowledge. This theory provides a comprehensive set of methods to promote constructivist learning environments. The theory focuses on problem solving and conceptual development in ill-defined, ill-structured domain. The CLEs theory assumes that the problem drives the learning, rather than acting as an example of the concepts and principles previously taught. The key to meaningful learning is ownership of the problem or learning goal. The CLEs theory suggests a set of instructional methods including selecting and providing appropriate problem, related cases or worked examples, learner-selectable information, cognitive tools, collaborative tools, social/contextual support. Instructional activities could involve modeling, coaching and scaffolding in the CLEs [6, 7].

2.2 Problem Solving Process

This process involves mapping the problem statement onto prior knowledge and constructing a personal interpretation of the problem (i.e., problem space). In the problem space, the solver attempts to decompose the problem while identifying an appropriate solution state. These processes are dynamically related, using a means-ends analysis to interactively reconcile the problem with each potential solution. The problem-representation process may be scaffolded by presenting a conceptual model to the learner during the problem-representation process. Conceptual models illustrate the structural relationships among the problem components (Fig. 1 presents a conceptual model of this problem solving process) [8].

2.3 Transfer of Learning

Thinking by analogy involves identifying a common relational system between two superficially dissimilar situations and generating further inferences driven by these commonalities [9, 10] In the most typical case of analogy, a familiar situation (the *base analog*) serves as a model by which one can comprehend a less familiar situation (the *target analog*). Analogical transfer is composed of three subprocesses: retrieving a prior knowledge structure, creating a mapping between it and the current problem or situation, and then using that mapping to generate new knowledge structures relevant to the application context. The transferred knowledge is typically assumed to be a declarative representation, but it can also include procedural attachments [11].

3 Theoretical Framework

The theoretical framework of the web-based learning environment consists of 5 theoretical base: (1) Context of learning management base which includes policies, targets, present situation, processes, and performances (2) Psychology base, i.e., Constructivist theory; cognitive constructivist [12] and social constructivist [13] and Cognitivism Theory; schema and mental model theory, information processing theory [14] and cognitive load theory, (3) Pedagogical bases, i.e., learning through collaboration and the principle of Constructivist learning environment design; OLEs model [15, 6] model and SOI model [16], (4) Media Theory and Technology base including media symbol system and web-based learning, and (5) Problem solving process and Transfer of learning base including problem solving process [6, 17] consisted of 7 process as follows: (1) problem representation (problem space), (2) Search for Solutions (3) Implement Solutions (4) Present Practice Problems (5) Support the Search for Solutions (6) Reflect on Problem State and (7) Problem Solution and transfer of learning [9, 10] consisted of 3 process as follows: (1) Retrieving a prior knowledge structure, (2) Creating a mapping between it and the current problem or situation, and (3) Mapping to generate new knowledge structures relevant to the application context. The theoretical framework was illustrated as below diagram (see Fig. 1).

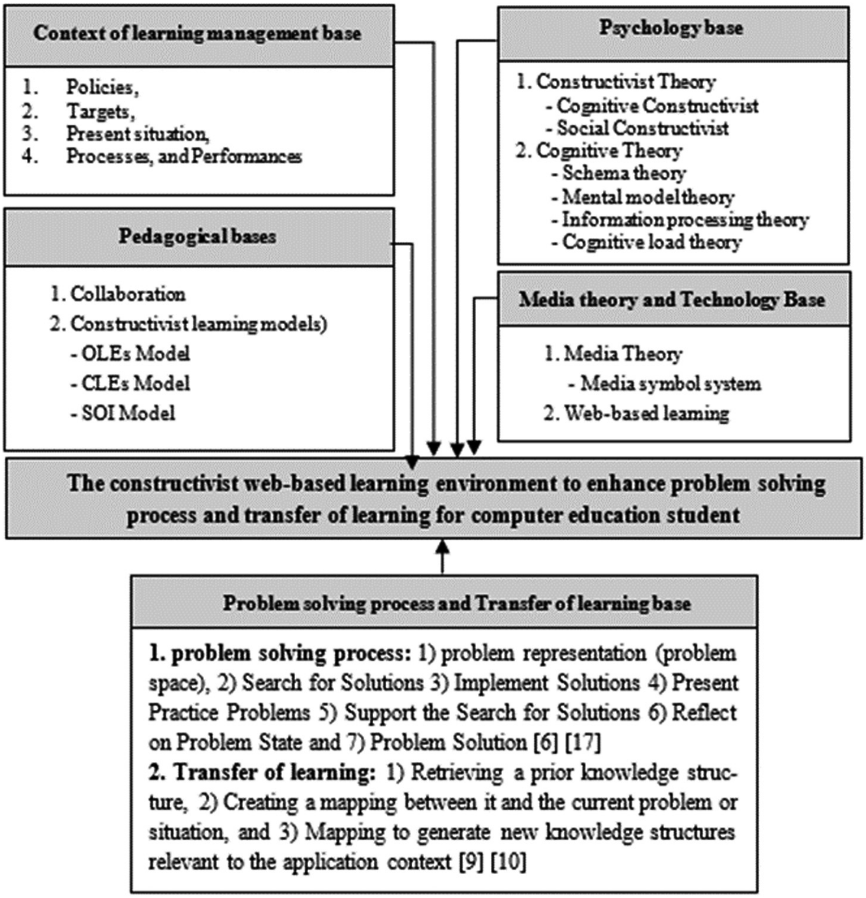

Fig. 1. Theoretical framework of the constructivist web-based learning environment to enhance problem solving process and transfer of learning for computer education student

4 Method and Result

4.1 Target Group of the Study

Target group in the design and development process consisted of (1) Experts –5 experts in content validity, 5 experts in instruction design who evaluated the learning environment, 5 experts in media to evaluate the quality of web-based learning, and 3 experts in evaluation to evaluate the quality of research instruments. (2) Students – 32 of fourth year undergraduate students majoring in computer education, Faculty of Education, Khon Kaen University comprised the target group.

4.2 Research Design

The developmental research Type I [18] was employed in this study. Several methods were used such as document analysis survey, and case study.

4.3 Research Instruments

The instruments in this study consisted of experimental instruments: the constructivist web-based learning environment to enhance problem solving process and transfer of learning and data collection instruments. Both were described below.

- The instrument for experiment included the constructivist web-based learning environment to enhance problem solving process and transfer of learning. The process of the design and development were as follows: (1) examined the principles and theories, (2) synthesized the designing framework of the constructivist web-based learning environment, (3) designed and developed the constructivist web-based learning environment based on above mentioned designing framework, and (4) evaluated the efficiency of the constructivist web-based learning environment.
- The instruments for data collection included the following: (1) the record form of document analysis, (2) the evaluation form for the experts, (3) The learners' problem solving process test form and the transfer of learning test form. and (4) the learners' opinionnaire toward the constructivist web-based learning environment.

4.4 Data Collection and Analysis

The researchers designed and developed the constructivist web-based learning environment to enhance problem solving process and transfer of learning based on the above-mentioned framework and components. It was tried out. The quantitative and qualitative data were collected and analyzed in the following was:

- The expert reviews in several domains, such as learning content, instructional design, media design, and evaluate the quality of research instruments. The data were collected by the researchers and analyzed through analytic description, interpretation and summarization.

- The problem solving process and transfer of learning tests. The quantitative data were collected and analyzed by descriptive statistics: mean, S.D., and percentage. The qualitative data were collected and analyzed by analytic description, interpretation, and summarization.
- The learners' opinions toward the constructivist web-based learning environment. The data were collected by the researchers and analyzed by analytic description, interpretation, and summarization

4.5 Research Results

The design and development of the constructivist web-based learning environment to enhance problem solving process and transfer of learning were as follows:

- **The designing framework**
  The designing framework of the constructivist web-based learning environment to enhance problem solving process and transfer of learning was synthesized based on the mentioned theoretical framework which had the following details: (1) The activation of cognitive structure, were designed based on Authentic context and Enabling context, [15] Problem solving process [6, 17] as Problem base, (2) The supporting cognitive equilibrium was designed based on cognitive theories [6] as Resources; designed based on OLEs Model [15] as Cognitive tools; designed based on Social Constructivist [13] as Collaboration [6], (3) The enhancement of problem solving process and transfer of learning, were designed based on Related Case [6], Problem solving process [6, 17] and Transfer of learning [9, 10] as Related Case, Fostering problem solving process center and Transfer of learning center (4) The enhancement in constructing knowledge and helping to cognitive equilibrium were designed based on CLEs Model [6] as Social support for education views; designed based on Cognitive apprenticeship [6] as Scaffolding, and Coaching.
- **The constructivist web-based learning environment to enhance problem solving process and transfer of learning**
  Constructivist web-based learning environment to enhance problem solving process and transfer of learning was produced based on the designing framework comprised of 10 components as follows: (1) Problem base (2) Resources (3) Cognitive tool (4) Collaboration (5) Related case (6) Fostering problem solving process center (7) Transfer of learning center (8) Social support for education views (9) Scaffolding, and (10) Coaching obtaining as description of each key element is shown in Table 1.
- **The constructivist web-based learning environment to enhance problem solving process and transfer of learning efficiency assessment**
  The experts' review which was found that the learning content, instructional design, and augmented reality book design, was appropriate detailed in Table 2.

  According to Table 2, the results of the assessment of the experts on the learning content (80%), the instructional design (86%), the constructivist web-based learning environment (84.25%) and the total of the assessment of the experts was 83.41.

Table 1. The key elements and descriptions the constructivist learning environment

Key elements	Description
1. Problem base & Learning Task	It was shown Problem base for enhancing the learners to construct knowledge and problem solving process
2. Resources	It was shown Resources to provide the domain of available information sources for solve the problem
3. Cognitive tool	It was shown Cognitive tool to provide the basic means for manipulating information (processing, manipulation, and/or communication tools)
4. Collaboration	It was shown Collaboration for supporting the learners to share their experience with experts by using Facebook and Google Classroom for expanding their multiple perspectives
5. Related case	It was shown a set of related experiences that novice students can refer to. Related case is to assist learners in understanding the issues implicit in the problem representation
6. Fostering problem solving process center	It was shown Fostering problem solving process center for should automate algorithmic tasks in order to offload the cognitive responsibility for their performance
7. Transfer of learning center	It was shown Transfer of learning center for enhancing analogy transfer of learning
8. Social support for education views	It was shown Transfer of learning center for enhancing analogy transfer of learning
9. Scaffolding	It was shown Social support for education views to support exploration, articulation, and reflection in learning environment, it is necessary to support learners by modeling, coaching, and scaffolding these activities
10. Coaching	It was shown Scaffolding to guide and support learning efforts (conceptual, metacognitive, procedural, and/or strategic scaffolding) It was shown Coaching to provide additional, intermittent prompts during the performance of particularly difficult tasks

- **The learners'** problem solving and transfer of learning
  The learners' problem solving was found that there were 70% (*mean* = 86.54, *S.D.* = 0.31) of qualified the learners from problem solving process test, and the protocol analysis and interviews was found that the learner's problem solving process as follow: (1) problem representation, (2) Search for Solutions (3) Implement Solutions (4) Present Practice Problems (5) Support the Search for Solutions (6) Reflect on Problem State and (7) Problem Solution. And the learners' transfer of learning was found that there were 70% (*mean* = 81.22, *S.D.* = 0.21) of qualified the learners from transfer of learning test, and the protocol analysis and interviews was found that the learner's analogy transfer of learning as follow: (1) Retrieving a prior knowledge structure, (2) Creating a mapping between it and the current problem or situation, and (3) Mapping to generate new knowledge structures relevant to the application context.

Table 2. The efficiency of learning environment

No	List assessment	Results of the expert (Percentage)
Learning content		
1.	Appropriate learning content	80
Instructional design: The design elements of the constructivist web-based learning environment		
2.	Problem base	80
3.	Resources	80
4.	Cognitive tool	80
5.	Collaboration	100
6.	Related case	100
7.	Fostering problem solving process center	80
8.	Transfer of learning center	80
9.	Social support for education views	80
10.	Scaffolding	80
11.	Coaching	100
		86
Media: Web-based learning environment		
12.	Functionality	86
13.	Reliability	85
14.	Usability	82
15.	Portability	84
		84.25
Total		83.41

- **The learners' opinions**
  The learners' opinions studies were learning contents, web-based learning design, and the design elements of the constructivist learning environment was appropriate, as well as the support knowledge construction and problem solving process and transfer of learning of learners detailed in Table 3.

Table 3. The learners' opinions studies

No.	List assessment	Results of the expert (Percentage)
1.	Learning content	89
2.	Web-based learning design	87
3.	The design elements of the constructivist learning environment	86
Total		87.33

According to Table 3, the results of the assessment of the learners' opinions studies on the learning content (89%), the web-based learning design (87%), the design elements of the constructivist learning environment (86%) and the total of the learners' opinions studies was 87.33%.

5 Conclusions

According to the above findings, found that the learners showed their problem solving process and transfer of learning, the results of this study as shown above, may cause from the instructional design for the constructivist learning environment with ID Theory. This is the instructional designs which are based on the principles and theory. In addition, the constructivist learning environment consisted of the following components; Problem base, Resources, Cognitive tool, Collaboration, Related case, Fostering problem solving process center, Transfer of learning center, Social support for education views, Scaffolding, and Coaching. Moreover, the constructivist learning environment not only develops 21st century skills, but also improves student motivation, which is another important aspect to success in the modern world. The constructivist learning environment improves student motivation in two ways: (1) introducing meaningful activities and (2) developing positive student perceptions of the constructivist learning environment used strategy. Future work should examine the interaction of these problem solving process and transfer of learning mechanisms and investigate whether people are capable of adaptively shifting between mechanisms depending on their prior knowledge and the processing demands of the transfer task.

Acknowledgement. This work was supported by the Innovation and Cognitive Technology Research Center, Faculty of Education, and the Research and Technology Transfers Affairs Division, Khon Kaen University.

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Artificial Intelligence and Data Mining in Education

Using Process Mining Techniques to Discover Student's Activities, Navigation Paths, and Behavior in LMS Moodle

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Abstract. This study explores using process mining techniques for analysis of Moodle logs. This topic is very interesting because the use and applications of e-learning solutions have been rising for last decade in the Czech Republic in both academic and commercial area. This study explores using process mining techniques to discover student's activities, navigation paths, and behavior in LMS Moodle. Data from 701 students from Silesian University in Opava, School of Business Administration in Karvina who followed an online course called "Informatics for Economists I" was used. The events log is from the winter semester of the academic year 2016/2017 and consists of 32 984 events, 33 activities which were conducted by 701 students. It was applied process mining techniques that are implemented in a tool called Disco by Fluxicon. The reader should learn from this study about current promising techniques for analyzing data from e-learning systems and especially about using process mining techniques for Moodle events log analysis.

Keywords: E-learning · Moodle · Process mining · DISCO

1 Introduction

The definition of E-learning is generally the following: it is a learning process that uses information and communication technologies to create different courses, distribute learning content, communication between students and educators and of course manage the study. There are several benefits of using e-learning such as cost-effectivity, saving time, learning anywhere and anytime.

There are many current promising techniques for analyzing data from e-learning systems such as Educational Data Mining (EDM), Educational Process Mining (EPM) and also Process Mining (PM). The paper will describe EDM, EPM and PM studies in section called "Related work", there will be section "Moodle logs process mining research using DISCO" presenting a case study about process mining research using DISCO tool to analyze events log from LMS Moodle that we have used at Silesian University, School of Business Administration in Karvina. And finally, there will be also section "Conclusion" with a description of results from process mining research.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 129–138, 2019.
https://doi.org/10.1007/978-3-030-35343-8_14

2 Related Work

There will be mentioned current promising techniques for analyzing data from e-learning systems such as Educational Data Mining (EDM), Educational Process Mining (EPM) and also Process Mining (PM).

Educational Data Mining (EDM) can be considered as an emerging discipline, concerned with developing methods for exploring the unique types of data that come from educational settings, and using those methods to better understand learners, and how they interact with those environments [1]. EDM can be applied mainly to improve learning style, evaluate the learning environment itself, to study the efficiency of the educational support provided by the learning tools [2]. Other current promising techniques is Educational Process Mining (EPM). The main goal of EPM is to extract knowledge from event logs recorded by an educational system [3]. Educational process mining (EPM) is one of the techniques used in EDM. EPM is very useful for analysis and discovery of processes and flows in the event logs which are generated by educational environments such as Learning Management Systems (LMS), Intelligent Tutoring Systems (ITS), Computer Supported Collaborative Learning (CSCL), etc.

EPM deals with the learning environment, interactions with tools and/or collaboration processes are enacted, supported by a software system such as a chat tool or an argument editor or a more general Learning Management System such as Moodle. The system records the interactions and transactions to some extent in an event log. The event log is used for process model mining. EPM can serve a number of purposes, such as Discovery, Conformance, Extension [4]. We can find widespread related work deals with data mining and process mining in a branch of educational and e-learning topic. We can find some case studies deals with using of EDM and EPM for events log analysis from widespread open-source LMS Moodle. EDM using Moodle event log is presented for example by [5]. They are using clustering techniques together with educational process mining (EPM). Another study [6] demonstrates the usage of data mining methods to the data collections that are stored in the LMS Moodle logs to finding and visualizing a synthetic social network based on the relationship between the students with the similar patterns of study behavior made through the educational process in an e-learning social network. Another study [7] has the main subject of interest in the experiments describing the students' behavior in LMS Moodle, which is recorded in form of events and stored in the log files. There was also published research called MOCLog–Monitoring Online Courses with log data [8] about the MOCLog project. The purpose of this project was to develop a tool for the analysis and presentation of log data on a Moodle server.

Process mining is a relatively young research discipline that sits between computational intelligence and data mining on the one hand, and process modeling and analysis on the other hand [9]. Process mining objectives are overlapping with those of other approaches, methodologies, principles, methods, tools, and paradigms [10]. The main idea of process mining is to discover, monitor and improve real processes by extracting knowledge from event logs [11]. The starting point for process mining is an event log and all process mining techniques assume that it is possible to sequentially record events such that each event refers to activity and is related to a particular case [12]. Process Mining Manifesto [12] deals with very important aspects such as process discovery, conformance checking, social network or organizational mining, construction of simulation models with the possibility of model extension and repair. Process mining is very useful for its ability to find out how procedures in real situations work and for comparing the actual process with some predefined process [13]. Process mining can be used in EDM for reflecting student's behaviors in terms of their examination traces consisting of a sequence of course, grade, and timestamp triplets for each student [14]. We can study also paper called Process Mining in the Education Domain [15] describing potential of process mining techniques in the educational domain such as how social mining techniques (implemented in ProM 6.3) can be used to examine and assess interactions between originators (training providers), training courses or pedagogical resources, involved in students' training paths. We also proposed a two-step clustering approach to extract the best training paths depending on an employability indicator.

3 Case Study: Moodle Logs Process Mining Research Using DISCO

The case study deals with a process mining research using DISCO tool for analyzing activities in LMS Moodle e-learning course and studying of student's behavior.

3.1 DISCO

Disco is a process mining software tools that provides according to the official website [16] useful functionality for optimizing performance, control deviations or explore variations such as automated process discovery, process map animation, detailed statistics, cases, filters, import and export, project management.

3.2 Moodle

Moodle is a well-known learning management system, especially in the higher education market all over the world. It is very important that Moodle collects usage data into log files with detailed information about activities, timestamps, users, courses, visited web pages, etc. This data can be used for creating reports and other analytics activities. Moodle is a web-based software package that allows you to create an environment in which an educational program can be delivered [18]. Moodle site involves three components [19]:

- Moodle code directory,
- Moodle data directory,
- Moodle database.

3.3 Moodle Logs

Moodle collects usage data from all sorts of activities that take place from the time a user logs in until he or she logs out. This data can be utilized for a range of reporting and analytics activities [20]. Moodle has a modest report viewing system built into it. However, for sophisticated log analysis, we need to look outside Moodle. Moodle keeps detailed logs of all the activities that users perform on your site. You can use these logs to determine who has been active on your site, what they did, and what they did it. Notice that Moodle display of the log files can be filtered by course, participant, day, activity, and action. We can select a single value for any of these filters [21]. Logs in Moodle are activity reports and are available at site and course level. We can see for example [22]: logs of course activity, logs of site activity, live logs from the past hour. The following Table 1 shows an example of event attributes in LMS Moodle. We can see an event attribute with its description.

Table 1. Event Attributes – LMS Moodle (Source: [7])

Event attribute	Description
TimeStamp	Date and time when the event was performed
StudentID	Each student has assigned its unique ID. Students are performers of analyzed events in LMS Moodle
CourseID	Each study course in LMS Moodle has its unique ID. CourseID is used for a sequence construction
IPAddress	Additional attribute. IP address of a client, from which a student entered LMS Moodle
Activity	Name of activity performed in LMS Moodle by a student
ActivityAttr	A detailed description of a concrete activity type, and for some activities is not necessary

Log analysis is according to [23] a data mining process-oriented to the analysis of computer-generated records (also called audit trail records, event logs or transaction logs).

3.4 Results of Process Mining

This subsection is organized as follows: characteristics of events log from Moodle, then will be described data pre-processing, creating of process model map, Overview – global statistics, Variants of Cases and IP address analysis.

Events Log From Moodle. There were used data from 701 students from Silesian University in Opava, School of Business Administration in Karvina who followed an online course called “Informatics for Economists I”. Events log is from winter semester of academic year 2016/2017 and consists of 32 984 events, 33 activities which were conducted by 701 students. Log timeline is including all events from 14.9.2016 to 24.1.2017.

Data Pre-processing. It was necessary to prepare input data for process mining analysis in Disco according to the minimum requirements that are detailed described in Disco User Guide [17]. Minimal structure for importing events log must contain at least these three elements: Timestamp, Case ID and Activity. Additional elements such for example resources, costs, IP addresses, the context of event, component or description can be used in advanced process mining analysis.

The following bullet item list shows columns of transformed events log for importing into Disco tools. We can see on the left side columns of transformed events log from Moodle and the right side is representing columns in Disco.

- User = Case ID in Disco,
- Source = Resource in Disco,
- Event Name = Activity in Disco,
- Timestamp = Timestamp in Disco.

There are also other columns in transformed events log that can be analyzed in Disco as other elements. All other elements can be filtered and used for detailed analysis. There are the following other columns in transformed events log from Moodle:

- affected users,
- the context of the event,
- component,
- description,
- origin,
- IP address.

There are some groups that are very important because of the affect users. We can define these subjects: Commander Stag, IT specialist from the e-learning department and of course students and teachers.

The Very important role is performed by Commander Stag. Commander Stag is a web service that serves as a transfer bridge between e-learning courses and student information system STAG. IS STAG is an information system of study agenda for universities in the Czech Republic. The system was created and developed by the Centre for Information Technology - Centre of Information Systems at the University of West Bohemia in Pilsen [24]. Commander Stag provides the following actions: the user enrolled in the course, the user subscribed to the course forum, the user assigned the role.

IT specialists from the e-learning department have a role of administrators and together with teachers also as study program managers. They are focusing especially on monitoring of all online courses provided by the university with an emphasis on all technical aspects of e-learning services. They are usually also monitoring the usage of the online courses by students and teachers and creating and managing login credentials for users to access online courses (user management).

Students are responsible for their own learning process including studying education materials, sending submissions or writing online tests if they are a part of online courses.

Teachers are responsible especially for the students' learning process and also general didactic aspects such as the content of online courses, updating grades and writing comments to the submissions. Teachers can also granted an extension for the submission. Teachers are also managing tests and chat communication activities for some courses. The range of activities is dependent on the type of course.

Process Model Map. There is shown in the following figure process model map with the absolute frequency of cases. There was used a filter of 50% of activities and 50% of paths because report with 100% of activities and 100% of paths is very complex and confusing for display in the form of a small image. Process model map visualization is dynamic in Disco tool so we can choose how detailed activities or paths we want to see in visualization. The following figure is representing visualization for process model map with case frequency displaying only 25% activities and 25% paths (Fig. 1).

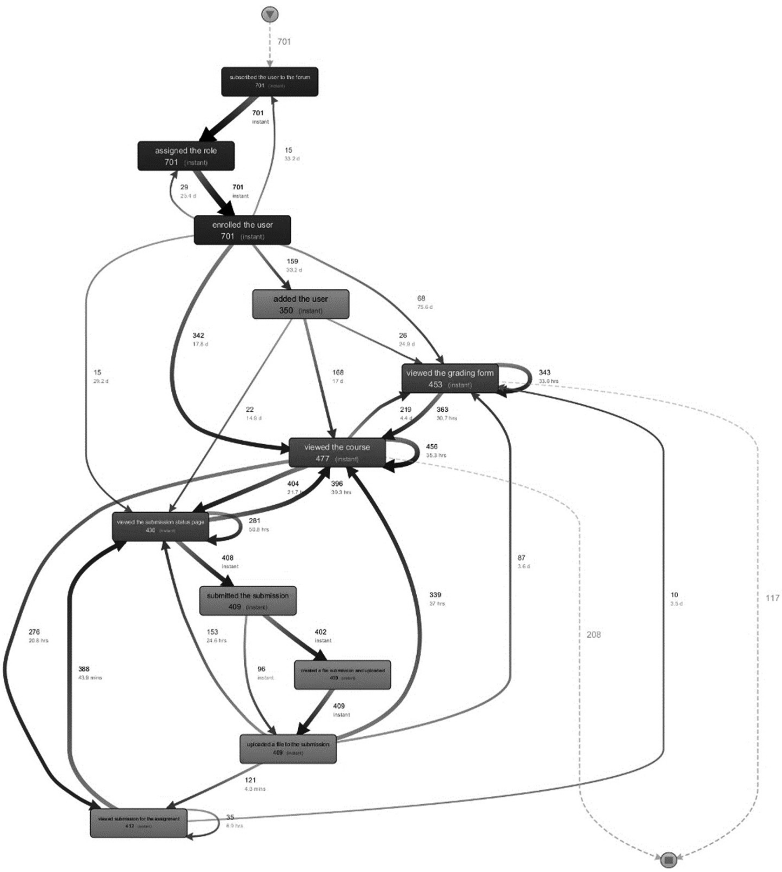

Fig. 1. Process model map for the most important activities (Source: Own analysis in Disco)

We can see that 701 students were subscribed to the forum of course and there were also for all of them assigned the role and all were enrolled in the course. These activities were performed by web service Commander Stag. We can analyze briefly activity of students: 477 students viewed the course, 430 students viewed the submission status page but only 409 students submitted their submission. All 409 students that submitted their submission also upload a file to the submission which was semester presentation work. Based on the changes of the parameters can be traced, how many times repeated activities (for example, if students are handed the task several times for repairs etc.). Some students even repaired the task four times. In another closer look at the process map can be seen how quickly tasks are embedded students evaluate teachers. Statistics are as follows: the minimum time between inserting the task of evaluating the student and the teacher was 26 min, the maximum time was 22 days. The median duration was 3 h and mean duration was 4.5 days. It should be noted that not all teachers continually repairing tasks, but that was the deadline for the submission of students at midnight December 18, 2017 and teachers were asked to grade submission tasks in the exam period, which began January 2, 2017.

We can see the top 20 activities from LMS Moodle events log in the following Table 2 with absolute and relative frequency.

Table 2. Top 10 activities from LMS Moodle events log (Source: Own analysis in Disco)

Activity	Frequency	Relative frequency
Viewed the course	14353	43.52%
Viewed the submission status page	459	13.92%
Viewed course module	4117	12.48%
Viewed the grading form	1492	4.52%
Updated the grade	860	2.61%
Assigned the role	739	2.24%
Enrolled the user	722	2.19%
Subscribed the user to the forum	719	2.18%
Viewed submission for the assignment	709	2.15%
Viewed the list of resources	643	1.95%
Uploaded a file to the submission	535	1.62%
Submitted the submission	529	1.60%
Updated the completion state for the course module	500	1.52%
Graded the submission	491	1.49%
Created a file submission and uploaded	409	1.24%
Added the user	351	1.06%
Viewed the user report in the grade book	317	0.96%
Viewed the profile for the user	185	0.56%
Viewed the list of users	136	0.41%
Viewed the user report	134	0.41%

The Performing detailed analysis of the behavior of students is made possible through statistics, individual cases of sequences of events and IP address analysis that are listed in the following subsections.

Variants of Cases. We can define a total amount of 490 different variants from cases. A variant is defined as the same sequence of activities. Variant 1 has a share about 12.13% and has the following sequence of activities: subscribed the user to the forum → assigned the role → enrolled the user → added the user. This variant is a pattern of activities for 85 cases (students). We can see that there is no activity performed by the student. Activities 1, 2, 3 were generated by Commander Stag (import from student's evidence system) and activity 4 was generated by the teacher (Dolák Radim). This behavior is typical for inactive students. These students never access to the course and never send a submission. We can find another different variant with no activity performed by the student such as Variant 2. It has a share about 5.99% and has the following sequence of activities: subscribed the user to the forum → assigned the role → enrolled the user. This variant is a pattern of activities for 42 cases (students). We can compare these variants of inactive student's behavior with variants of active students such as for example Variant "22" with the following sequence of activities (Fig. 2):

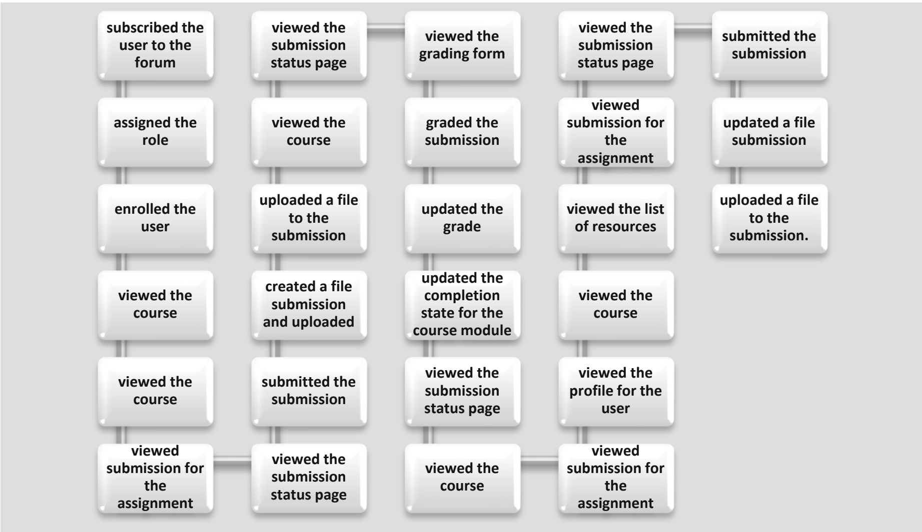

Fig. 2. Variant22 (Source: Own analysis in Disco)

IP Address Analysis. There were recorded accesses to e-learning course from 1 677 unique IP addresses. This subsection will analyze the frequency of accesses from each unique IP addresses with the greatest activity.

The most activity was recognized from web service stag-ws-slu.cz with the frequency of 2150 access which is a share of 6.52% from the total amount of detected IP addresses activities. Service stag-ws-slu.cz is in events log called Commander Stag and it is importing users (students) from study agenda information system STAG to e-learning courses. I have analyzed that access from PC classrooms has a share of 12.87%. There are a high proportion of instructional computers in classrooms B-207 and B-208 with a total share of 1.97%. It was analyzed that access from faculty staff PC has a share of 7.21%. It is also possible to analyze the number of visitors from a student dormitory network. It was found that there is a range of IP addresses within the dormitory network used by accommodated students with a share of 2.1%. Very low was access to analyzed e-learning course from computers situated in faculty library with a share only 0.15%.

4 Conclusion

There was mentioned related work about promising techniques for analyzing data from e-learning systems such as Educational Data Mining (EDM), Educational Process Mining (EPM) and also Process Mining (PM) in this paper. Process mining techniques are very common for Moodle logs analysis referring to educational processes, activities, teachers, and students acting. The case study describes the process of analyzing process map with e-learning processes in a course called "Informatics for Economists I" with the following characteristics of its Moodle events log: 32 984 events, 33 activities which were conducted by 701 students and log timeline including all events from 14.9.2016 to 24.1.2017.

The main results and outputs from case study research are the following: detailed characteristics of events log from course, data pre-processing of events log, creating of process model map, overview – global statistics, and IP address analysis. Process mining is very useful also for analyzing student's behavior. We can distinguish different variants (patterns) conduct within the e-learning course such as variants with no student activity during e-learning course.

Acknowledgment. The work was supported by SGS/8/2018 project called "Advanced Methods and Procedures of Business Processes Improvement".

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Scaffolding Learning for the Novice Players of Go

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Abstract. From DeepBlue to AlphaGo, computer game is the drosophila of Artificial Intelligence. For the AI services of assisting human learning, we believe computer board games can also play the role of the drosophila. From the viewpoint of social development, after the rise of AI, human need more ability of logical thinking and judgement than before. Advocating computer games is an excellent tool for the training of logical concepts and hence produces positive impact in our society. Since human Go players have a different process of reasoning compared to Go programs today, we need to develop learning methods that more closely match how humans think. Deep Learning takes inspiration from human cognitive processes and is similar to human intuition. As a result, Go programs developed with Deep Learning generate plays that feel more human. We use Deep Learning and Reinforcement learning to develop scaffolding learning system for Go. The system contains human-like Go programs with various strengths, which allows novice players to learn the game progressively. We also introduced a simplified variant of Go, named Jungo. The game could help the beginners to learning the game of Go.

Keywords: Scaffolding learning · Deep Learning · Computer games · Go

1 Introduction

The event of AlphaGo defeating the human grandmaster made a great impact on the board-game society. First, the population is much more then that estimated before. Secondly, the newest techniques that Google used in AlphaGo attract pervasive focuses and interest, which include deep learning (DL), reinforcement learning (RL) and deep reinforcement learning (DRL). Thirdly, this trend gives strong impetus to the application of computer-assisted learning in game playing. In terms of the development of society, with the rise of AI, humans need better logical decision-making ability and critical thinking skills more than ever. Board games are great tools for exercising logical thinking. For children, playing board games helps them develop logical thinking abilities, and cultivates their resilience and perseverance. It is shown by a Gerontology research institute in Japan that Go could improve cognitive functions.

Computer Games is the drosophila of Artificial Intelligence. A series of AlphaGo programs created a brand new history for AI [9, 10]. For the AI services of assisting human learning, we believe computer board games can also play the role of the drosophila. Since human Go players have a different process of reasoning compared to

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 139–148, 2019.
https://doi.org/10.1007/978-3-030-35343-8_15

Go programs today, we need to develop Go learning methods that more closely match how humans think. Deep Learning takes inspiration from human cognitive processes and is similar to human intuition. As a result, Go programs developed with Deep Learning generate plays that feel more human. We use Deep Learning and Reinforcement learning to develop gradient learning system for Go. The system contains human-like Go programs with various strengths, which allows novice players to learn the game progressively. This paper will describe the learning theories and framework of this system. Then gives the experimental results and rewards from the users.

2 Theories and Approaches

2.1 Scaffolding Learning and Implementation

The basic learning theory of our learning system is Scaffolding Theory. The Theory is based on the concept of Zone of Proximal Development (ZPD) in constructive theory by Vygotsky [1, 2]. For people to develop their mind they have to seek knowledge from someone who is wiser than you, like a mentor. In this study, we developed a concept based on scaffolding theory proposed by Wood et al. [3–5]. It involves a kind of "scaffolding" process, mentions that the novice or child need the direction by auxiliary to solve a problem, achieve their goal and finish a task which would help their unassisted efforts. As a consequence, we expanded the concept of learning gradient in this research to find out the most suitable auxiliary enable to guide learning effectively, and maintain learners to focus on the direction correctly in learning.

The concept of learning gradient is that the best opponents to play against are in fact not the top experts of the field. Instead, one improves the most when playing against someone who is just one step higher on the skills gradient. If you play against an opponent who is much higher on the skills gradient, you may not have the ability yet to comprehend the opponent's actions, so the experience turns out to be less helpful for learning. Take AlphaGo for example, despite the program have reached the power to defeat professional opponent, they are helpless to an armature to learn Go.

However, it is difficult to use traditional algorithm to perform different level Go programs with natural moves. Ikeda and Wu used Monte Carlo tree search (MCTS) to produce various strategies moves and natural position control. However, Naturalness moves may cause a problem for the MCTS based methods [14, 15].

Our method used different DCNN models trained from different Go game records, then use different MCTS parameters setting. Finally, we could make many human-like Go programs with various strengths. Using deep learning and reinforcement learning, we can establish a gradient learning system, allowing learners to choose a suitable from the Go program, and increase the efficiency in learning. The framework of our system is based on that of AlphaGo, which is constructed by deep convolutional neural network (DCNN) [13] and Monte Carlo tree search (MCTS) [6]. Monte Carlo tree search (MCTS) is a heuristic search algorithm for some kinds of decision processes, most notably those employed in game play. MCTS was introduced in 2006 for computer Go [6–8]. MCTS is a kind of reinforcement learning algorithms. For computer Go, DCNN is trained by Go games to be policy network and value network. The two networks are used in MCTS. The strength of a Go program is based on the quality of the DCNN and the simulation number of the MCTS [10–12].

Table 1 shows the ranking system for Go. The ranking system for Go uses Kyu, Dan and Pro. The lowest ranking is 25K. Novice player levels are from 25K to 10K. Kyu amateur levels are from 9K to 1K. Dan amateur/Expert levels are from 1D to 9D. Pro levels are from 1P to 9P. For easy to compute the system, we denote each rank as a serial number as in Table 1. Our system has 6 DCNN models for 6 kinds of Go programs as in Table 2. The 6 DCNN models are trained from 6 levels of Go games, respectively. There are 32 different levels Go programs from 25K to 7D. Each is made with different model and different MCTS parameters setting for the 32 levels, respectively. Go players can choose the suitable Go program as his opponent.

Table 1. The ranking system for Go. Each rank is denoted by a serial number.

	Novice			Kyu amateur			Dan amateur			Pro		
Rank	25K	…	10K	9K	…	1K	1D	…	9D	1P	…	9P
#Srial	0	…	15	16	…	24	23	…	33	34	…	42

Table 2. The setting for different strength Go programs.

Levels of programs	#trained games	#trained boards	Accuracy	#MCTS simulations
>10K	100,000	21,940,127	43.30%	500–1,000
7K–9K	120,000	27,563,832	45.80%	1,000–3,000
4K–6K	120,000	27,170,879	46.30%	1,000–3,000
1K–3K	120,000	27,069,159	47.50%	3,000–5,000
1D–3D	120,000	26,905,989	48.40%	6,000–12,000
4D–7D	120,000	26,494,730	50.22%	12,000–100,000

2.2 Jungo

Even though we develop the Go program for the novices, the rule of Go is difficult to some beginners. It is considered that Go is hard to learn as the method of calculation in outcome is complicated to understand. The outcome of a Go game is decided by both players' territory. The territory of Go is an abstract concept for the beginners. For the example in the left board of Fig. 1, it is hard for a Go beginner to understand the 5 white stones marked by A are dead. So the beginner will miscount the result.

Jungo is a simplified variant of Go. The rule of Jungo is introduced by Ming-Wan Wang and Shi-Jim Yen. Instructors use one of the easiest ways to calculate scores in Jungo, and it allows the beginners to learn Go in ten minutes. The method in calculating of Jungo is that the person who keeps the most stones on the Go board is the winner, and everyone gets easily to know the outcome only calculating the stones on the board. For the example in the left board of Fig. 1, the number of black stones is 13 and white stones is 16. Thus, White won the game. In fact, Black should keep placing stones on the board as much as possible. The final board may be as the right board in Fig. 1.

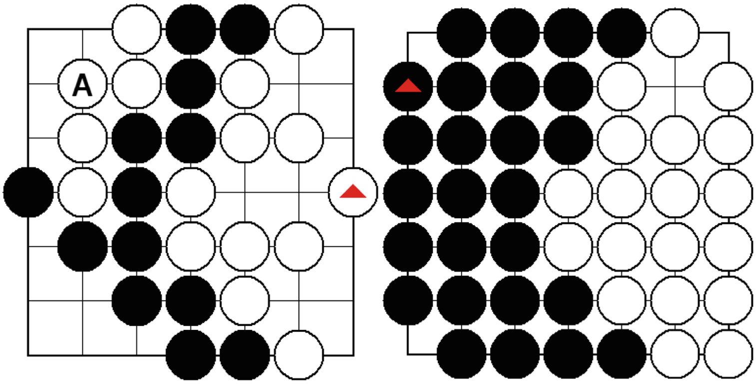


Fig. 1. A Go game (left) and a Jungo game (right).

There are only three basic rules of Jungo:

1. Jungo is played by two players, Black and White, who consecutively place a stone of their color on an empty intersection of a square grid.
2. Directly neighboring stones of the same color form blocks. When all the directly neighboring intersections of a block are occupied by the opponent, the block is captured.
3. When the game is finished, the player keeping the most stones of the board wins the game.

Once to know these rules, the beginners could play a Jungo game. We use 7-way and 9-way board in Jungo. There is no need to figure out the abstract Go concept "shitatsu (life and death)" and "territory", everyone can play a game immediately but retaining the content of Go. After learning the basic skills in the small board with Jungo, we can adapt the grand board in ordinary rules of Go easily. Jungo is similar to Go, which means that "if you can play Jungo, you play Go". Thus, Jungo could be the scaffolding for the Novice Players of Go.

3 Experiment Result

U-gen of Nihon Ki-in is an internet website for playing Go. The different strength Go programs are operating in U-gen of Nihon Ki-in with the robot account shows in Fig. 1. There are 32 Go programs, named as GoTrend. More than 1 million with GoTrend games were played on U-gen (Fig. 2).

3.1 Novice Players Rank Improvement

The basic idea is practice makes perfect. We collect 1,273,722 novice players' games from U-gen of Nihon Ki-in and analyze the change of the 6612 players' ranking. The duration is about 1 years.

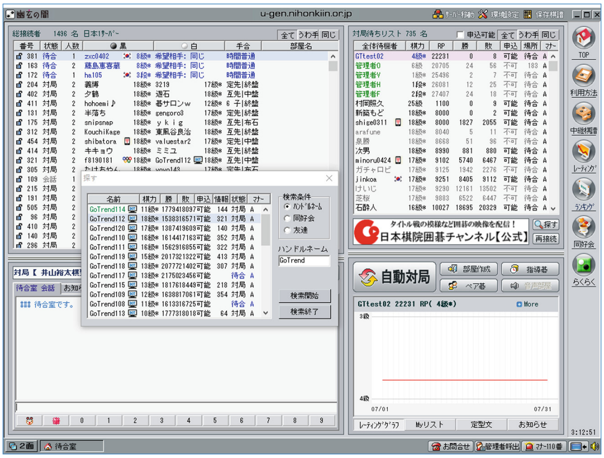


Fig. 2. U-gen Go website of Nihon Ki-in.

Figure 3 is the statistics result of all the players and the players who played 200–300 games. The y axis is the rank change. Figure 4 shows the average ranking improvement of total players and the players who played 200–300 games. The gradient of the total players is 0.005535, which is the average improvement of the total players. In average, each of the players plays less than 100 games in U-gen of Nihon Ki-in. The gradient of the players who played 200–300 games is 0.008204. Thus, the players who played more games make more improvement. There are 4855 players played with our Go programs GoTrend in all the 6612 players. Because many GoTrend programs were running in U-gen of Nihon Ki-in, the novice players were easily to find opponents, our Go programs are helpful for the novice players. Next subsection shows that our programs are helpful by the questionnaire.

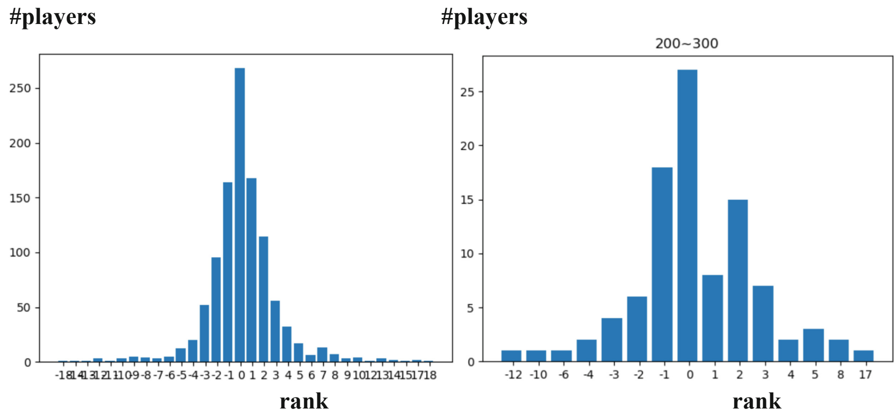


Fig. 3. The statistics result of all the players and the players who played 200–300 games.

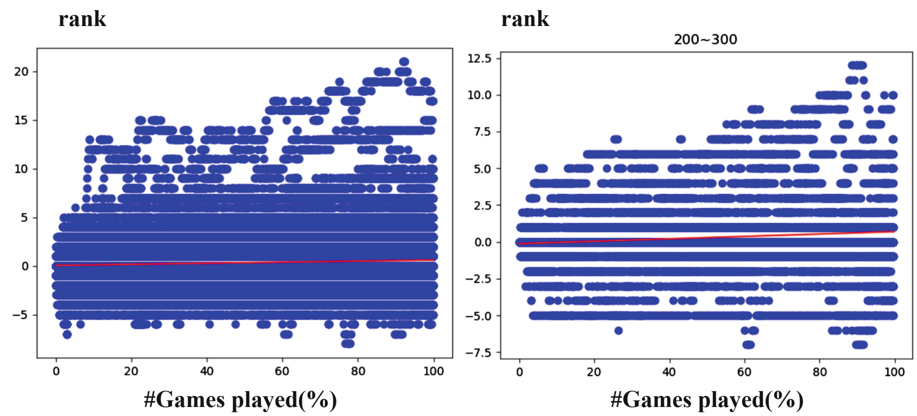


Fig. 4. The improvements of total players and the players who played 200–300 games.

3.2 Users' Reward

So far, the system has provided about one million AI Go moves per month. U-gen no ma of Nihon Ki-in conducted a questionnaire survey for the users. The results of the questionnaire show that the system is quite popular and with the positive comments among users. Figure 5 shows why users like this system. Therefore, we can conclude that many people started to contact AI services out of curiosity, then prefer to use this system. As can be seen in Fig. 6, users believe that the power of Go in the system is appropriate and there is no sense of naturalness moves.

Figures 7 and 8 show the user's power of Go distribution and the user's Go age. Users age of Go is mostly more than 10 years, and the power of Go is mainly amateur. Thus, it can be seen that most of the users are elderly people. Because of attracting the use of senior citizens, this system has great potential in the development of long-term care system. In addition, the users in this system are part of the novices. A big problem for novices in the past is that it is not easy to find an opponent. Because the system provided a variety of opponents with different power of Go, the number of novices has increased a lot, which is one of the contributions of this system.

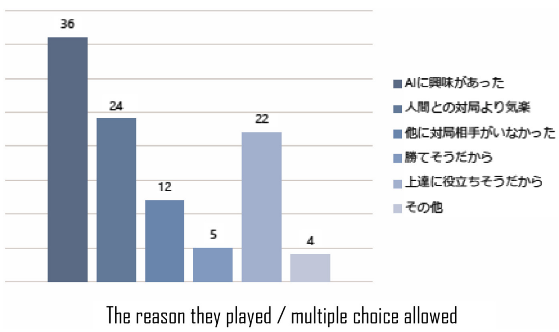
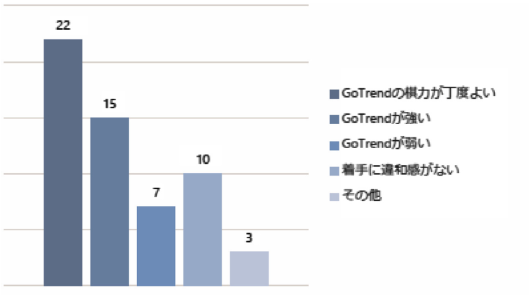


Fig. 5. The reason they played with our system/multiple choice allowed.



(Good point – answered by those who have played / multiple choice allowed

Fig. 6. The good points of our system.

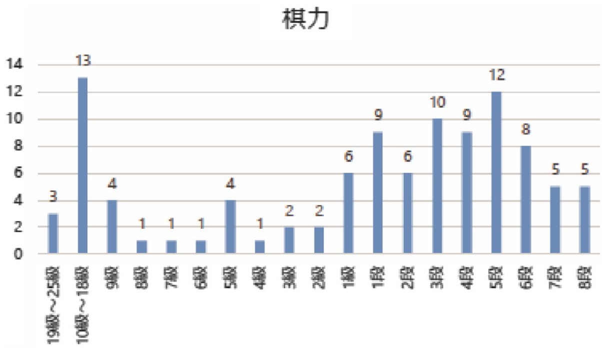


Fig. 7. Go ranks of the users.

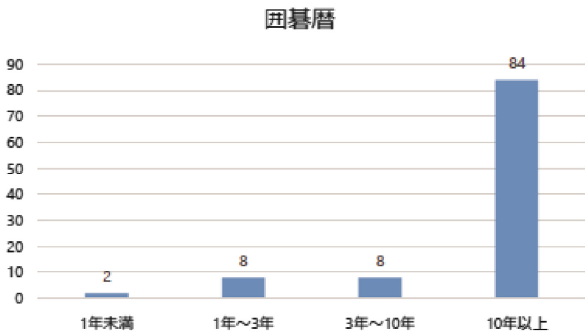


Fig. 8. The Go history of the users.

3.3 Promotion of Jungo

Lots of people are interested in Go, but they are obstructed by the difficulty in learning. Jungo makes the beginners get started the game of Go, in the situation that they do not have any knowledge about Go. To know they have learned Go, while enjoying the process and identifying the outcome of playing Jungo. With Jungo, who makes people to learn Go immediately, then the number of potential Go players is 7 billion. Go is the best tool in communication, and people can become friends easily after playing a game of Go. We have held many promotional activities of Jungo in Japan and Taiwan, and the results are productive.

For example, there were one hundred the elderly and children participated in the festival of Jungo in Hualien on November 27 in 2018 (see Fig. 9). A questionnaire was made in this festival. There are 105 responses in the questionnaire as in Fig. 10. According to the questionnaire, most of people responded enthusiastically. More than a half people can learn how to finish a Jungo game. That is difficult for the game of Go.

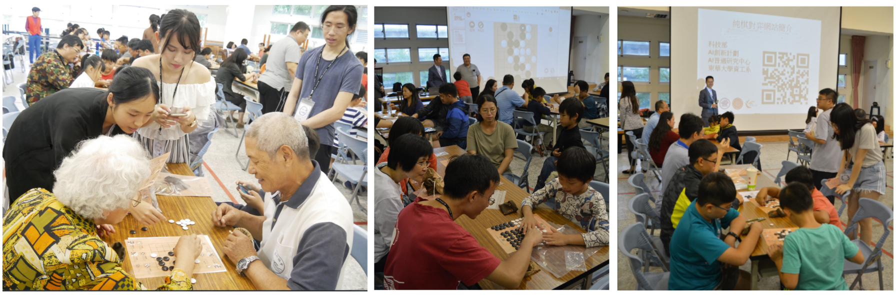


Fig. 9. The Jungo activities for elderly and children.

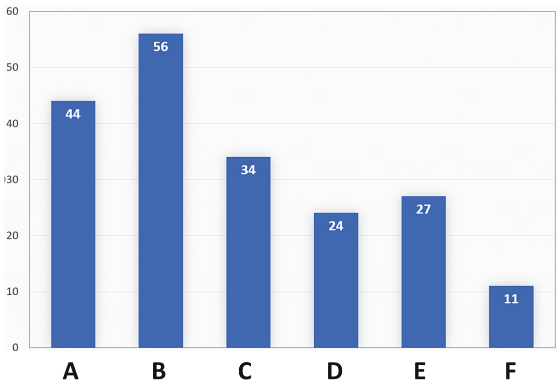


Fig. 10. The questionnaire for the 105 Jungo beginners. A: To Understand the rules of Jungo. B: Ability to finish a Jungo Game. C: To Enjoy the Jungo game. D: To cultivate the thinking ability. E: To improve relationship. F: To prevent dementia.

4 Conclusion

This paper applies Scaffolding learning theory on the game of Go. We use Deep Learning and Reinforcement learning to develop gradient learning system for Go. The system contains human-like Go programs with various strengths, which allows players to learn the game progressively. Go players can choose the suitable Go program. For the beginner, it is hard to find his opponent. The reason is that the beginner may be not familiar with rules of Go. Some trouble may be happened in playing. Our system supports many different levels Go programs. Any player could find a suitable opponent in a short time on the system. The experimental results show that those Go programs can help Go beginners to improve their ranking. We also introduced Jungo, which is a simplified variant of Go. Jungo can be scaffoldings for the people just started to learning the game of Go. This paper show that Scaffolding Theory is useful for the novices. In the future, we will also apply the learning theory to the amateur kyu and dan players of the game of Go.

Acknowledgment. The authors would like to thank anonymous referees for their valuable comments in improving the overall quality of this paper. This work was supported in part by the Ministry of Science and Technology of Taiwan under the contract 106-2511-S-259-001-MY3 and the contract 108-2634-F-259-001- through Pervasive Artificial Intelligence Research (PAIR) Labs, Taiwan.

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An Image Recognition Practice for Using Mobile Phone During Class

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Abstract. In the past, Student Engagements were measured in the form of statistical scales. In previous studies, some scholars divided the bad behaviors of students into 19 categories, covering 22 subcategories. These bad behaviors may represent a lack of either Student Engagements or intention to study the course. With the rise of artificial intelligence, some students' lousy behavior recognition in the classroom can be used as the judgment standard of Student Engagements. In this work, we try to use image processing technology combined with machine learning and use SVM method to determine whether students have the use of mobile phones in the classroom. We divide the processing stage into several parts, namely pre-processing, segmentation, extract features, and machine learning. In the futures, we may use artificial intelligence to judge the dis-behavior of students during class; it is also possible to assist in the validation of research related to such scales in the past.

Keywords: Student Engagements · Using mobile phone · Student misbehaviors

1 Introduction

Nearly decades, there has been an increasing interest in the e-learning in class [2, 3, 5]. While all seem to agree that e-learning can assist teaching and increase student learning outcomes, opinions differ as to how to evaluate the Student Engagements. Among them, some scholars began to study how to assess Student Engagements [4, 8]. However, for students who have given up on themselves, any assessment of motivation for learning is meaningless. Any learning methods are also ineffective. We can assess whether the student has self-abandoned behavior from the class misbehavior of the student. Sun & Shek finding that 19 categories of student misbehavior, including of 22 subcategories, in-class (Table 1) [6].

Due to the rapid development of artificial intelligence in recent years, there have been many practical applications in image recognition. This study will attempt to use the image recognition function to determine whether the student is using the mobile phone during class. With the help of technology, it can find out automatically that the student who has no willingness to learn.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 149–154, 2019.
https://doi.org/10.1007/978-3-030-35343-8_16

Table 1. Student problem behaviors insides the classroom (Sun and Shek [6])

Category	Subcategory
1. Talking out of turn	• Asking nonsense question • Calling out • Having Disruptive conversation
2. Disrespecting Teacher	• Disobedience/Refusing to carry out • Instructions • Rudeness/Talking back/Arguing with teacher • Offending/Attacking teacher
3. Doing something in private	• Dealing with personal stuff • Doing Homework • Using electronic device (Texting, Playing games, surfing webpages, Listening to music) • Irrelevant drawing
4. Verbal aggression	• Attacking classmates • Gossiping • Quarreling with classmates • Speaking foul language • Teasing classmates
5. Out of seat	• Changing seats • Wandering around the classroom
6. Sleeping	
7. Playing	
8. Clowning/Making fun	
9. (Habitual) Failure in Submitting assignments	
10. Non-attentiveness/looking out of windows	
11. Non-verbal communication via Body language, Paper	
12. Physical aggression	• Attacking classmates • Destroying things • Pushing classmates • Striking classmates
13. Isolating classmates	
14. Making noise	e.g., Rocking Chair, Paper-Playing, Singing
15. Copying homework	
16. Forgot to Bring textbook and other learning materials to class	
17. Disturbing other classmates	
18. Invasion of privacy	
19. Intimate physical contact	

2 Methodology

The methodology will be divided into several parts to explain, Fig. 1 shows the process of image recognition. First of all, Image must be pre-processing and segmentation; after that, the Extract features code will be executed. Finally, Machine Learning (SVM) is necessary for image recognition. All systems developed by both OpenCV 3.0 and CMake 3.3 in this study.

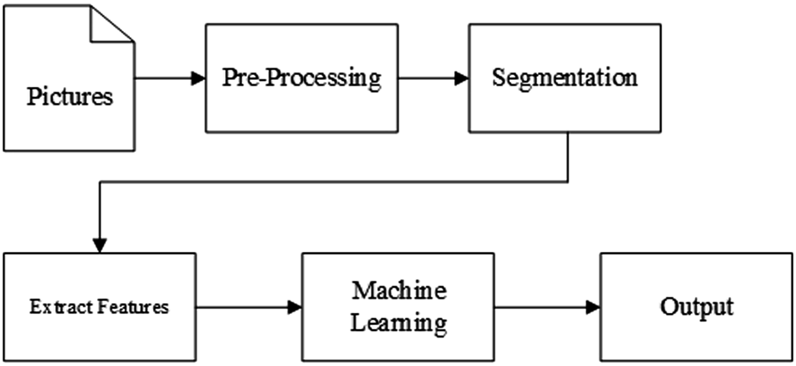

Fig. 1. Image recognition flow chart for using mobile phone behavior during class.

2.1 Images Pre-processing

Before image recognition, we must do images pre-processing, including removing image noise, binarization images, separating objects in the scene, and so on. These steps usually use algorithms (e.g., Contour Detection or Connected Component Extraction).

Fig. 2. Example result for pre-processing. The picture on the left is the result of removing the background, the image in the middle is the result after grayscale, and the picture on the right is the result of binarization.

In the pre-processing, if the noise in the image is not processed first, the noise data may be divided into an object during the segmentation stage to cause a recognition problem. Here we use OpenCV's medianBlur function to remove image noise. After removing image noise, Second is to remove the photo background, and Third is binarization images. Figure 2 shows the example result.

2.2 Images Segmentation and Outline

The most important in the segmentation phase is the ability to segment objects. In general, color photos, photos without background removal, and photos that are not processed by noise will cause abnormal segmentation of objects. It is best to add Gaussian blurring in the Pre-processing phase to reduce object segmentation errors. In this experimental case, since the user's clothes and the mobile phone are the same (Black Color), the effect is not satisfactory when the binarization image is used to divide the object. Instead, it can get the outline of the user's hands and mobile phone when we use OpenCV's Gaussian blur effect with the grayscale processed image (Fig. 3).

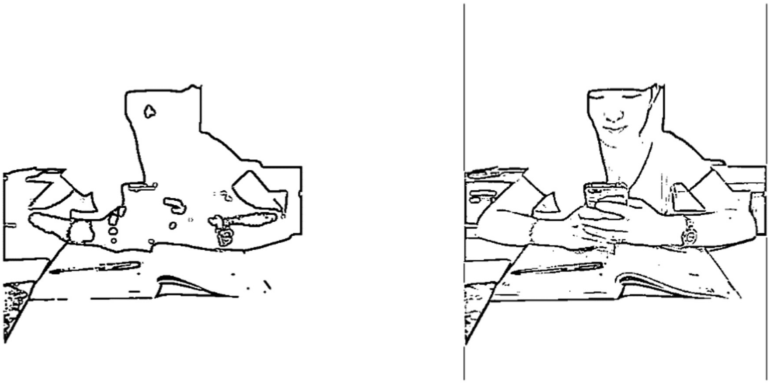

Fig. 3. Example result for image segmentation and outline. Left: segmentation for binarization image. Right: segmentation for the grayscale image after the Gaussian blur effect.

2.3 Extract Features

In this section, we refer to the previous study of detecting the use of mobile phones while driving for setting our features [1]. Meanwhile, we simulated a variety of photos which is using mobile phones during class (Fig. 4).

Fig. 4. Example of a variety of photos which is using mobile phones during class

2.4 Machine-Learning: Support Vector Machines (SVM)

In this work, we use the SVM (Support Vector Machine) for image recognition. The SVM (Support Vector Machine) belongs to supervised learning for binary classification [7]. The training data set used by the SVM does not limit the minimum number of data. But when more images are provided during the training, better results can be obtained. All pictures are divided into two parts, one is training data sets, and the other one is used for testing. SVM will use training data set for learning how to identify using a mobile phone during class. After that, we can input images (test data) for testing weather Machine Learning work operationally.

3 Experimental Result

Figure 5 is the partial result of the experiment. In the part of the shape recognition of the mobile phone, the program can be recognized and marked. However, due to the angle of the camera, we found that some test images can't be identified student's hand. In other words, it means the model needs more extra features for learning and testing.

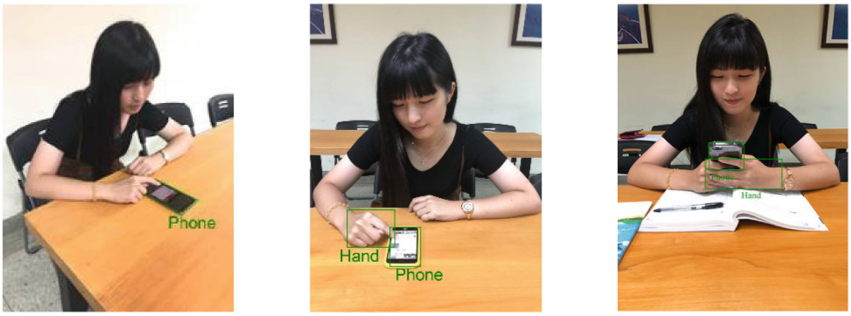

Fig. 5. The partial result of the experiment. Left: identify phone success only. Middle & Right: Identify both Hand and Phone success.

4 Conclusion and Suggestions

In this work, we try to adapt SVM image recognition technology for assessing if the student is using a mobile phone during class. Although there are not enough eigenvalues and training set data, some parts cannot be identified successfully. However, in the past, the related research on learning motivation in education was carried out through a statistical scale. If we can use artificial intelligence in the future to judge the dis-behavior of students during class, it is possible to assist in the validation of research related to such scales in the past.

On the other hand, using a mobile phone during class is one of dis-behavior in Sun & Sheik's research [6]. Other tasks (e.g., writing homework in class, speaking in class, sleeping or leaving the seat) can be technically using artificial intelligence to identify. It can reduce the burden on teachers if there is a successful dis-behavior recognition system. It will also help teachers to find out students with sparse learning. Therefore, in the future, this research will continue to use this kind of recognition algorithm for trying to identify other class dis-behaviors.

Acknowledgment. This work supported by Ministry of Science and Technology, Taiwan, R.O.C. under Grant No. MOST 106-2511-S-346-002-MY2.

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Building a Chinese Facial Expression Database for Automatically Detecting Academic Emotions to Support Instruction in Blended and Digital Learning Environments

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Abstract. This paper specifically focuses on how to build a Chinese facial expression database collecting the facial expressions of college students and describes a strategy to develop an automatically detecting technique for academic emotions to support teachers making better decisions in blended and digital learning environments. There are some famous worldwide databases of facial emotion expressions, e.g., Amsterdam Dynamic Facial Expression Set (ADFES), Montreal set of facial displays of emotion, or Brazillian FEI database. Their major collections are full facial expression of western people with very limited Asian or Chinese faces. Because some emotion facial expressions might be culturally bounded, it arises the necessity to develop a Chinese facial expression database as a critical step to develop an automatically facial emotion expression dictating technique with high accuracy.

Keywords: Facial expressions of emotion · Basic emotions · Academic emotions · Blended and digital learning environments

1 Introduction

Facial expression is one of the major outlets of emotions [1–4] while emotion is the most fundamental core of learning motivation [5]. Findings concerning the universality of facial expressions of emotion can help people in a range of professions requiring face-to-face interactions improve their skills in reading the emotions of others. Reading facial expressions of emotion can aid the development of rapport, trust, and collegiality. In the classroom, they can also be useful in making on-going motivational, concentration and comprehension evaluations for instructional decision. Teachers can read the emotions of their students' faces when it is inappropriate to discuss about emotions during lecture time. Reading emotion become a way to obtain cues about the progress of their lesson plans so that teachers can adjust instructional activities accordingly and deliver instruction more effectively.

However, teachers may not understand students' emotional facial expression, especially a subtle (low-intensity versions of full-facial expression) or micro (very

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 155–162, 2019.
https://doi.org/10.1007/978-3-030-35343-8_17

briefly displaying true emotions followed by a false emotional reaction) expressions of emotions. Because facial expressions of emotion are part of our evolutionary history and are a biologically innate ability, we all have the ability to read them. It is an ability that gets better on the job in our everyday lives. But most people are not very good at recognizing some types of emotions, subtle or micro expressions of emotion.

The average accuracy rates of facial emotion expression for people prior to training in Matsumoto and Hwang's study [6] was 0.48; if joy and surprise – the 2 easiest expressions to recognize – are excluded, then the accuracy rate drops to 0.35. And there are many individual differences. Thus if a teacher obtains the ability to read facial expressions of emotion – especially micro and subtle expressions – may help he/she be more efficient in teaching or classroom management, then there are needs for training or developing an instructional aid with capacity to automatic detecting facial expressions of emotion.

Another problem arises in digital learning environments as there is frequently no supervisor to assess how students are physically and emotionally reacting to the delivered contents. Usually when students taking a course online, they are quite easy to lose concentration and result in poor academic performance. An instructional aid with capacity to automatic detecting facial expressions of emotion may help to identify the reasons when visibility is low and monitoring is delayed.

This paper specifically focuses on how to build a Chinese facial expression database collecting the facial expressions of college students and describes a systematic process to fine tune an automatically detecting technique for academic emotions to support teachers making better decisions in blended and digital learning environments. The facial expression recognition model developed by the 3rd and 4th authors [7] is composed of two parts: automatic face recognition and automatic facial expression recognition with action units [8, 9]. Regarding the facial recognition part, Wu and team [10] based on the Neural Aggregation Network (NAN) [11] to design a Region-Aware Aggregation Network (RAAN) technique which assign various weights to regions of a full face. The blocking, blur or out proportion regions or images were inhibited; then the regional image vectors were enhanced and aggregated into one for onetime comparison in the face database.

Second, a cascaded convolutional neural network based face detection method proposed by Zhang and team [12] is adopted to detect faces and feed the facial images into the automatic facial expression recognition system designed by Wu and Lin [7], to predict the facial expressions. GoogLeNet, inception v1, is simplified to be the recognition model. The authors construct a proprietary dataset from YouTube and combine it with some public dataset to train the model. In this paper, the generic model in Wu and Lin [7] is employed for the experiment. The testing and training data are from facial expression databases, such as CK+ [13], RaFD [14], and ADFES [15], as well as a self-bulid proprietary. The number of testing data is 1808 and training data is 23,591 (in Table 1).

Wu and Lin [7] proposed a Weighted Center Regression Adaptive Feature Mapping (W-CR-AFM) to transform the feature distribution of testing samples into that of trained samples. By means of minimizing the error between each feature of testing sample and the center of the most relevant category, W-CR-AFM can bring the features of testing samples around the decision boundary to the centers of expression categories;

Table 1. The configuration of the testing and training data

Type	Database	Anger	Disgust	Fear	Joy	Sad	Surprise	Neutral	Total
Testing	CK+	63	91	40	130	42	150	114	630
	RaFD	88	90	87	90	89	83	89	616
	ADFES	80	80	80	80	82	80	80	562
Training	RaFD	494	494	466	493	485	452	493	3,377
	ADFES	367	373	367	367	380	343	362	2,559
	Proprietary	407	244	411	6,545	2,105	941	7,002	17,655

therefore, their predicted labels can be corrected. When the model which is tuned by W-CR-AFM is tested on extended Cohn-Kanade (CK+), Radboud Faces database, and Amsterdam video facial expression sets, their approach improves the recognition accuracy by about 3.01%, 0.49%, and 5.33%, respectively. Compared to the competing deep learning architectures with the same training data, our approach shows the better performance.

There are some famous worldwide databases of facial emotion expressions, e.g., Amsterdam Dynamic Facial Expression Set (ADFES), Montreal set of facial displays of emotion, or Brazillian FEI database. Their major collections are full facial expression of western people with very limited Asian or Chinese faces. Because some emotion facial expressions might be culturally bounded, it arises the necessity to develop a Chinese facial expression database as a critical step to develop an automatically facial emotion expression dictating technique with high accuracy.

2 Methods

2.1 Participants

1. Emotion expressers: The preliminary database contains the expressions of 5 male and 7 female participants from 3 colleges in Taiwan. They had to performed two types of emotion tasks before a camera taking their full faces.
2. Facial expression coders: 10 coders (5 males and 5 females) took a 10-week training program to tag facial expression of emotion through The Facial Action Coding System (FACS) [16].

2.2 Emotion Tasks and 9 Emotions

1. Demonstration task based on personal emotion event: The expressers were asked to tell the experimenter about their most remarkable and memorable personal events of 9 emotions. Then they demonstrated and displayed the required expressions of each emotion.
2. Authentic task: 9 physical stimuli were designed and displayed to induce emotions. our Authentic task refer and modification to Xing Zhang's study [17]. For examples, the expressers were asked to taste a cup of odd drink with a sick smell or listened to a joke.

3. 9 emotions in this study: Nine emotions were included in both Demonstration task and authentic task. Six basic emotions are: Joy, Surprise, Anger, Disgust, and Fear. Three academic emotions are included: anxious, bored and confused. They are critical for the identification of successful learning or comprehension.

2.3 Setting

The camera and expressers: In Figs. 1 and 2, the expressers are situated in the center spot with 5 cameras (C920r HD Pro of Logitech) synchronized to record simultaneously. In front of the expresser, there was a computer to display the two emotion tasks. Several recorded examples of facial expressions of emotion are in Fig. 3.

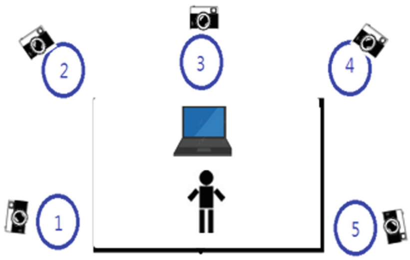

Fig. 1. The configuration of cameras and emotion expressers.

Fig. 2. The real setting of cameras and emotion expressers.

Fig. 3. The pictures of the emotion expressers with neutral faces.

2.4 Procedure

1. Camera recording: The emotion expressers sit in the center of camera area. After the calibration, 5 cameras were acting simultaneously to record facial expression from the onset, peak, and offset. For the demonstrating tasks, the recording length were 15 s (5 s for onset, peak, and offset). A 10-min break were there between two emotion tasks. For the authentic task, the camera was on when the physical stimuli started and off when the stimuli come to the end. A pulse oximeter was also on for monitoring the expresser's oxygen saturation and pulse.
2. Facial coding: Ten coders to tag facial expression codes were trained 10 weeks based on The Facial Action Coding System (FACS, Ekman & Friesen, 2003) [16]. They were trained to distinguish 44 Action Units (AUs) and their compositions. They all passed the test with 34 videos of facial expressions of emotion designed by Ekman and Friesen.

3 Preliminary Results

The Chinese facial expression database for learners has been built with 12 participants making 216 video clips that were separated into 284,953 facial pictures (see Table 2) of low to high intensity of emotional levels. The facial expressions recorded with demonstration task were of higher intensity while some of those recorded with authentic task are of low intensity or subtle in nature.

Table 3 shows the accuracy rates of each basic emotions identified by facial expression recognition model and by our trained coders. The facial expression recognition model to identify academic emotions are still on the design process.

Table 2. Pictures of facial expression of emotions in Chinese facial expression data base for learners

Emotions		Demonstration task	Authentic task	Picture amount
Basic emotions	Joy	8,388	8,731	17,119
	Surprise	8,555	17,777	26,332
	Anger	7,660	20,697	28,357
	Sad	7,651	59,753	67,404
	Disgust	7,746	16,343	24,089
	Fear	7,618	12,527	20,145
Academic emotions	Anxious	7,747	16,682	24,429
	Bored	8,069	22,033	30,102
	Confuse	7,254	39,722	46,976
Total		93,915	214,265	284,953

Table 3. Accuracy rate to identify 6 basic facial expressions of emotions either by machine or by the coders

Emotions	Demonstration task		Authentic task	
	AI accuracy confidence level	Coder accuracy	AI accuracy confidence level	Coder accuracy
Joy	99.1%	97.3%	98.6%	100.0%
Surprise	2.3%	26.7%	1.0%	50.0%
Anger	11.6%	46.7%	2.6%	21.0%
Sad	22.4%	30.1%	46.3%	6.0%
Disgust	1.4%	64.3%	19.2%	30.0%
Fear	1.1%	15.7%	6.3%	3.3%
Total	23.0%	46.8%	29.0%	35.1%

4 Conclusion and Implication

This study described how we have built a Chinese facial expression database collecting the facial expressions of college students which focused on 6 basic and 3 academic emotions. The facial expression recognition model with W-CR-AFM (Wu and Lin) [7] has been designed by the 3rd and 4th authors. The basic facial expressions of emotion, like joy, has been automatically recognized reasonably well, but it is hard for the model to recognize other subtle facial expressions and the faces of certain races (e.g., Asian or Chinese) have not been trained by this model before. The Asian facial expression dataset is very rare at this moment to train an elaborated facial expression recognition model. Therefore, what we have contributed to build Chinese facial video dataset is valuable. The relations among facial expressions and races may be a valuable research in the future to make good use of training data and train a better model to do the cross-race facial recognition.

In this preliminary stage, the most successful automatic detection conducted by the facial expression recognition model is the recognition of joy facial expression which is in accord with the previous studies (citation). The second best is the detection of sad facial expression though the detection rate is still low (demonstration task 22% and authentic task 46%). Because this is the very first database to collect emotion facial expression beyond the scope of basic emotions (Ekman) [4], we are still working on the facial expression recognition model to detect facial expression of academic emotion (bored, anxious and confused). These three academic emotions are expected to be highly related to the effectiveness of teachers' instruction. In the next stage we plan to combine the bio-feedback of pulse and automatic detection of head orientation and tilt to assist the detection on academic emotions.

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Augmented and Virtual Reality in Education

Obtaining Managerial Skills in Virtual Reality

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Abstract. Virtual worlds are very versatile environments. It isn't a didactic device narrowly focused on one or a few uses, but it allows a wide range of activities, teaching forms and methods. In the paper's introductory part, virtual worlds are defined in the conceptual and content areas. Further, their technological concept is described. Using the available knowledge, didactic-technological aspects have been defined to accelerate the use options of these virtual worlds in the role of the educational environment. The research aim is to describe the benefits and drawbacks of using virtual reality in management teaching and to answer the research question RQ: Are managerial skills training in a simulated environment more effective than other teaching methods, thanks to clarity? In the paper's application part, a research survey on respondents groups A and B is described, whose aim was to compare the deployment of virtual reality in teaching managerial skills of bachelor students with the traditional way of teaching. Subsequently, a questionnaire was carried out by all respondents, where 7 questions were placed with the possibility of evaluation on a scale of 1–5 points where 5 points are the highest ranking. The basic questionnaire file included all respondents. The Student's T Test was used. Conclusions and recommendations were formed, based on the synthesis of the acquired knowledge.

Keywords: Virtual environment · Virtual reality · Experiment

1 Introduction

The power of virtual reality is manifested in various trainers. It's particularly suited to training skills where every mistake can cause loss of human life or high material or financial damage. Typical examples are training for surgeons, soldiers, pilots as well as electronic engineers. Virtual reality is also used by businesses to train their employees. Ideally, it's necessary to train skills in areas where the usual teaching methods are very expensive or impossible - for example, training service processes on non-stop technologies in the chemical industry or in power engineering. The trained person is immersed in a virtual world that cuts them off from the bustle. In a safe environment, they learn, develop skills and gain confidence. Additionally, people enjoy it. There is also a simulator to help merchants and customer support workers improve their sales and social skills. Training need to be customised by users on the web where they choose the environment, customer appearance, scenario, etc.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 165–174, 2019.
https://doi.org/10.1007/978-3-030-35343-8_18

Virtual worlds are ranked among virtual environments. However, the virtual environment that falls within the realms of virtual reality is so broad and has undergone such significant development that it may designate objects that are fundamentally different, in some properties being at the opposite ends of the distinctive scale. Therefore, it's crucial to define this term more precisely for this paper's purposes and to further determine what scope and place the studied virtual worlds have within the concept of virtual environments.

In view of the above-stated aim, the following part of the paper deals with virtual worlds from a terminological viewpoint, technological specifics and didactic aspects. The next chapter will define a common theoretical basis in which virtual worlds can be seen as a potential means of education and will allow the subsequent classification and categorisation of these environments on the basis of didactic-organisational aspects.

2 Related Theory and Research

2.1 Virtuality-Virtual Reality

According to Jeřábek [1], the concept of virtual reality can be examined from a philosophical point of view and from a later established Information and Communication Technologies (ICT) viewpoint. In both concepts, this concept has undergone long evolution, in which its meaning has fundamentally changed. From a philosophical viewpoint, we now perceive the word virtual as "almost the same", "practically as," and "almost real." In common communication, virtual is understood as "the opposite of real, when real represents a material reality," although from a more detailed study of the genesis and shifts of virtual perception within the philosophical directions it follows that it isn't the opposite of real, as it is a complex conceptual architecture, where according to Heim [2], virtual isn't possible without the elements of reality on which it is based, and real contains the layers of virtuality that precedes reality. Virtual reality is an event or object that is real with its effect but it isn't real.

In terms of ICT, the term also has several meanings. In addition to designation of software systems temporarily replacing or extending hardware elements (such as virtual servers, virtual disks, virtual memory, etc.), Levy [3] considers virtual reality in the context of an artificial communication environment. In this context, virtual reality can be a theatre scene as well as a variety of chat rooms, forums and websites on the internet, i.e. imagined places and spaces within the communication networks.

On the other hand, the virtual environment within ICT is considered to be simulation of the environment - a virtual reality, a computer-created three-dimensional environment into which one completely immerses and experiences an immersive interactive experience [4]. In this conception virtual reality is considered immersive on all sides, but cannot be modified. Depending on the degree of immersive feeling, virtual reality systems are divided into Non-immersive, Semi-immersive and Fully immersive [5]. Interactive virtual reality is active with the possibility of modification. Similarly, Heim [2] identifies the concept of the user's passive and active participation in the matter of virtual reality, i.e. the tension of virtual reality, leading the user from passivity to activity, by the fact that navigation and orientation in the environment itself requires creative decision-making. Also, there is the manipulation and perceiving concept corresponding to Austakalnis [6] the interactions concept. The environment interacts with the user and simultaneously conveys emotional sensations to the user.

Resources of virtual reality are generally among the so-called new media. Lister [7], in his work New Media: A Critical Introduction, looked at the identification of typical and defining features of new media. He has formulated six key features of new media, namely virtuality, immersion, interaction, digitality, dispersion and hypertextuality. Heim [2] identified seven aspects of virtual reality, namely simulation, interaction, artifice, immersion, telepresence, full body immerse and network communication.

2.2 Virtual Environment

The notion of reality includes the complex of objects, relationships and dependencies that surround us. By contrast, the notion of environment within a broad concept of virtual reality implies a local anchor, which is more likely than virtual reality, and is therefore more suitable for describing virtual worlds.

Also, the term virtual environment is used for a relatively wide range of meanings. If the concept of virtual reality refers to a virtual environment in the context of an artificial communication environment, a webpage, any communication (such as a mailing or chatting) programme or applet, if used within a network of interconnected communities, suites the definition. The virtual environment in this context is often also spoken in the context of the Web 2.039 phenomenon. Frequent synonym for virtual environment is cyberspace. The term cyberspace refers to an artificially created environment in which we can find digital objects as well as virtual user representations. Some authors refer to cyberspace as a collective intelligence environment, "a new communication environment that rises from a global computer connection. This term not only refers to the digital communication infrastructure but also the vast ocean of information within it, and the human beings that float in it and supply it [8].

Říha [9] however, defines cyberspace in the context of a simulated environment and explains the cyberspace concept - specifically Avatar cyberspace (AC) - as a gradual convergence of WWW, MUD42 and virtual reality technologies. He notes that the first virtual world could only emerge after the introduction of the Virtual Reality Modelling Language (VRML) for 3D modelling on the Internet in 1995.

One of the other frequent virtual environment concepts is the Multi User Virtual Environment (MUVE), a multi-user virtual environment. Previously, it was also used as a term involving Multi User Dungeon (MUD), Object Oriented (MOO), Massive Multiplayer Online Role-Playing Game (MMORPG), from which virtual worlds have emerged with convergence with social networks. Today, it's used either as a virtual world synonym (VW), or to designate MMORPGs that are not entirely focused on the game - those with a relatively free scenario. The key feature of MUVE is the aspect of a story, a quest that doesn't need to be here at all, or it may be in the background, and for educational use it's important to maintain the relative freedom of movement and non-linearity of the story [3]. Smith-Robbins [10] defines a virtual environment (and prefers the term of virtual worlds) based on four main characters:

1. It's the persistence or permanence of the world that continues to exist even after disconnecting the user.
2. Multiple users can be connected.
3. Representation of users through avatars.
4. Broad availability through the network.

This group of virtual worlds (which, according to the above mentioned characteristics, does not include CAVE simulators, etc.) is often referred to in the professional literature as a desktop virtual environment. Unlike virtual reality systems, the virtual environment does not require special hardware equipment (although the use of special peripherals is not entirely impossible) and is focused more on users social communication rather than on exact real-world simulation and imitation. Virtual reality systems also usually do not work with avatars, instead of viewing avatars, first-person view is used, and they are mostly single-user systems.

Although the quality of the environment simulation is not too high in virtual worlds compared to special CAVE systems and therefore the level of user immersion in the virtual world is relatively low, the fact that the user can navigate freely (including flying or teleportation) in 3D virtual space remains an important aspect. Another important aspect is the ability to share space and objects between users/players, the user's ability to communicate and collaborate. Virtual worlds have the features of a collaborative virtual environment, and some authors, for example, [11–13] emphasise this aspect. According to Pečiva [14] collaborative virtual environment can include productive software, such as military simulators, engineering software, distributed rendering software, and distributed simulations (such as meteorological weather models) as well as interactive communication tools (including video conferencing) and network games.

Some writers are putting up hopeful virtual desktop environments in the future, Kapp and O'Driscoll [13] even consider the virtual environment as an Internet version 3.0 application. Whilst in the Internet's first generation, users were connected to the internet, consisting of predominantly static presentations by one author reaching out to the general public, the shift to the so-called Web 2.0 meant a fundamental change when the pages were created dynamically by the users themselves who interconnect "via" the internet with each other. The above-mentioned authors expect a further qualitative shift of the Internet towards a 3D environment (3D Internet - 3Di) with users "inside" the Internet. Other authors consider the so-called Semantic Web (Web 3.0) to be the basis for the distribution of data processed on the basis of their meaning) [15]. However, both concepts are not inconsistent and their parallel use is possible, or the future Internet could integrate elements of both concepts.

2.3 The Importance of Games in Training

The game, like any experience form, naturally shapes the attitudes and value system of game-participants - players. Players are mostly engaged in the game emotionally, they can hardly have neutral attitudes towards simulated reality. Simulation games develop the skills and features that participants can use during almost every activity. It is work with information (information retrieval and transmission, organisation and information processing, information evaluation, information retention and re-use and its system analysis), personal skills and competences (concentration, time management) and social skills (assertiveness, effective communication, trust-building, co-operation, negotiation, conflict resolution, decision making, creative thinking, problem solving, understanding of relationships, holistic perception, empathy, imagination and visualisation and anticipation).

Games are considered an effective pedagogical tool. Children learn natural and non-violent play before they have any structured and organised pedagogical action. Also, a number of educational concepts and approaches recognise the game as a full-featured and very effective tool used as part of teaching. Children as well as adults are taught by game. Games are used in training the army and police, training managers as well as developing the specific skills of employees and workers in many fields. Abroad, educational and training simulations and simulation games are sought-after, valued and often expensive goods - some of the games listed in the UK Managerial Games catalogue cost up to twelve thousand British pounds. This is perhaps because people remember most of what they really do or experience (up to 80%) and less of what they see (50%) or hear (20%). Games bring many benefits. Above all, they provide a secure learning environment. The non-binding feature which is characteristic for the game allows players to risk, break out of stereotypical solutions, and look for unusual alternatives. Learning from mistakes is often as intense in emotional terms as in reality. In the game, however, we can see a mistake as a useful lesson that would mean a disaster in life. Games also provide an emotionally-friendly environment that helps everyone's involvement, openness and personal development. Games give the opportunity to repeat and practice situations, to repeat the situation and the chance to gradually improve and correct your own mistakes. The secret of learning success often lies in repeating.

3 Objective and Methodology

Empirical research is based on a model of action research conducted by a researcher in university practice.

3.1 The RQ Research Question Has Been Formulated

Are managerial skills training in a simulated environment, thanks to clarity, more effective than other teaching methods? **H0 hypothesis**: In Group B, which has teaching with the promotion of virtual reality, the students have a more positive attitude to the subject than in Group A, which has teaching conducted in a traditional way. Research was conducted on two selected groups of students from 1st year Bachelor degree programmes, with 10 students in each gender-balanced group A and B. A deliberate, non-random selection was used to obtain a sample of respondents. Research was conducted within one academic year - 2017/2018. Both groups discussed the same issue according to the subject syllabus, group A in the form of classical teaching with a teacher and interpretation of the problem, which was practiced on illustrative examples. Group B had an explanation of the issue and practice in virtual reality at their disposal.

One of the most popular PS VR virtual reality solutions for the Sony PlayStation 4 game console has been used for this. Virtual reality is easy to add to the gaming console and play in a completely absorbing environment. Subsequently, a survey was carried out by all respondents in the form of a questionnaire, where 7 questionnaires were placed with the possibility of evaluation on a scale of 1–5 points where 5 points are the highest ranking. The basic questionnaire file included all respondents. The Student´s T Test was used. Conclusions and recommendations were formed, based on the synthesis of the acquired knowledge.

4 Results and Discussion

Games usually provide much more opportunity to develop skills and abilities that are useful in real life situations than life itself. Games teach system and abstract thinking. They allow players to go through most of the four stages of Kolb’s learning cycle with experience. Selecting essential characteristics of experience and the forming an general lessons play an important role in the cycle. It is precisely this generalization and its integration into the overall picture of reality is a key moment of learning by experience and, at the same time, an excellent exercise of systemic thinking. Games help in capturing players and engaging them in learning. Participants of all ages are able to get into the game and engage in it. The degree of passion helps to overcome the feeling that someone is old for learning as well as the priori resistance to any pedagogical influence. However, this may also have negative sides if someone tries to cheat or spoil the game for others in an attempt to win at all costs. People take it in the game as hard as in real life. Games develop the player’s entire personality. They can simultaneously develop more personality dimensions. Through games it’s possible to achieve both cognitive and affective goals simultaneously, i.e. the so-called holistic development of the player:

1. the current skills development,
2. attitudes
3. knowledge.

Each game has the potential to develop all these three areas, and the emphasis depends only on the goal the educator wishes to achieve.

For virtual environment with a built-in scenario, teaching can only be carried out within the limits that this scenario provides. In this case, the scenario fundamentally affects the decision to select the virtual environment. Although there are environments with a built-in scenario created primarily for learning needs, but there are not many of these. More often, the originally purely gaming environment is used for some narrowly defined learning activities (e.g. strategic games to simulate economics, fantasy game for playing roles, etc.)

The virtual environments that do not include the scenario are much more versatile, or it’s possible to suppress the scenario (for example, by changing the gaming mode in Minecraft from Survival to Creative) or the scenario may not be used and can be ignored (for example, SecondLife’s focus on the embedded economy).

Environment that is open and at the same time supports scripting is the most versatile. It is sometimes possible to use external specialised tools to create and edit scenarios (e.g. Pivote tool in SecondLife) [16, 17].

Questions for evaluating the education course. Rating on a scale of 1–5 points, where 5 points are the highest ranking

1. Does the training teach information and skills in a non-distorted way?
2. Does the training develop cognitive processes?
3. Is the training rationally and emotionally impressive, i.e. it pulls-off, activates the student to experience learning?
4. Does training respect the system of science and knowledge? Is education educational, i.e. it develops the moral, social, work and aesthetic profile of the student?
5. Is the training natural in its course as well as consequences?
6. Is the training applicable in work, in real life and does it bring school closer to life?
7. Is the training adequate for students? (Tables 1, 2 and 3)

Table 1. Evaluating the education course – group A. Rating on a scale 1–5 points, where 5 points, where 5 points are the highest rating.

	Group A - traditional education, number of respondents 10										
Question 1	3	4	2	2	2	3	2	2	4	4	2.8
Question 2	2	3	4	3	3	3	3	2	2	1	2.6
Question 3	3	2	4	3	3	3	3	2	3	1	2.7
Question 4	4	3	4	4	4	3	3	3	2	2	3.2
Question 5	3	4	3	4	4	3	3	3	2	2	3.1
Question 6	4	4	3	4	4	2	3	3	2	2	3.1
Question 7	4	4	3	3	3	3	3	2	2	2	2.9

Source: customized processing

Table 2. Evaluating the education course – group B. Rating on a scale 1–5 points, where 5 points are the highest rating.

	Group B - education with virtuality support, number of respondents 10										
Question 1	3	3	3	4	2	3	4	3	2	4	3.1
Question 2	4	4	4	3	3	3	4	3	3	3	3.4
Question 3	4	5	5	5	4	4	5	4	5	5	4.6
Question 4	4	3	3	3	4	3	3	2	3	3	3.1
Question 5	3	4	4	4	4	3	3	4	4	5	3.8
Question 6	4	4	5	5	5	4	3	3	4	4	4.1
Question 7	4	4	5	5	5	4	3	4	4	4	4.2

Source: customized processing

Table 3. *t*-Test: paired two sample for Means.

	Group A	Group B
Mean	2,914285714	3,757142857
Variance	0,051428571	0,336190476
Observations	7	7
Pearson correlation	–0,146669832	
Hypothesized mean difference	0	
df	6	
t Stat	–3,415868327	
$P(T <= t)$ one tail	0,007107857	
t Critical one-tail	1,943180281	
$P(T <= t)$ two-tail	0,014215713	
t Critical two-tail	2,446911851	

Source: customized processing

On the basis of the above results, the **H0 hypothesis was not rejected**. Students welcome and positively appreciate the possibility of promoting teaching in a virtual environment.

5 Conclusions and Recommendations

Games allow you to experience storylines that actually last for days, months or years on lesson time. They can take us into the past and bring into the future. Thanks to our imagination, they can create the illusion that we're on a distant island, in a big business headquarters, in a spaceship or in an anti-nuclear bunker after a nuclear disaster, without leaving the classroom or the exercise room. They allow us to experience exotic life roles, as well as allowing to look at our other roles through different eyes. In most cases, expensive equipment nor the risk of damaging or destroying anything worthy is not necessary.

Therefore, games minimise the cost of both financial as well as time-consuming energy and resources - while maximising the benefits. It depends only on the goal the educator wants to achieve. Games minimise costs while maximising benefits and allow for meaningful shortcuts in time and space. Games allow you to experience storylines that actually last for days, months or years on the lesson time. They can bring us into the past and into the future. Thanks to our imagination, they can create the illusion that we're on a distant island, in a big business headquarters, in a spaceship, or in an anti-nuclear bunker after a nuclear disaster, without leaving the classroom or the exercise room. They allow us to experience exotic life roles, as well as allowing our other roles to be seen through different eyes. In most cases, expensive equipment nor the risk of damaging or destroying anything worthy is not necessary. Therefore, games minimise the cost of both financial and time-consuming energy and resources - while maximising the benefits.

Loureiro and Bettencourt [18] conclude that the learners in virtual environments tend to feel more confident, open, creative and participatory to learning. The results in this study are somewhat similar. Although it was a small group we can say that the students have a more open and free attitude because they can complete their tasks and communicate with friends or other people in different places by virtual conferences and virtual gatherings in these environments whenever they want. So, the students stated that they are able to go wherever they want and learn about those places, without being exposed to boundaries of traditional education [19].

The survey we conducted had its limitations in the number of participating students. The results showed that students appreciated the way of teaching with the support of virtual reality with higher scores. From the viewpoint of educators, it's an attractive opportunity to enrich the teaching but it also is time-consuming and creativity-demanding.

Acknowledgments. The paper was written with the support of the specific project 2019 grant "Determinants of cognitive processes impacting the work performance" granted by the FIM UHK and thanks to help of students František Hašek and Majid Ziaei Nafchi.

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Design and Development of Constructivist Augmented Reality (AR) Book Enhancing Analytical Thinking in Computer Classroom

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Abstract. One of the greatest advantages of Augmented Reality (AR) in education is that AR increases student knowledge construction. This study aimed to design and development of constructivist augmented reality book to enhance analytical thinking. Developmental research (Type I) was employed in this study. Research methodology is developmental research; developmental research consisted of 3 processes which were designing process, developing process, and evaluating process. The procedures were as following: (1) to examine the principles and theories, (2) to synthesize designing framework, (3) to design and develop the constructivist augmented reality book according to above mentioned designing framework, and (4) to evaluate the efficiency of the constructivist augmented reality book. The results revealed that: (1) The constructivist augmented reality book enhancing analytical thinking comprise of 6 components as follows: (1) Problem base, (2) Resources, (3) Collaboration, (4) Scaffolding, (5) Coaching and (6) Analytical thinking training centre. (2) The efficiency of the constructivist augmented reality book enhancing analytical thinking was found to be appropriate as following: learning content, media designing and augmented reality book designing.

Keywords: Constructivist learning environment · Augmented reality · Analytical thinking · Web-based learning environment

1 Introduction

Analytical thinking skills must be developed as a foundation for many professions. Most have only learned to use one or more data analysis tools without first learning the concepts, principles, and practices of analytical thinking that must be developed before those tools can be used effectively, through the years, new technologies have often enabled new opportunities for education. For example, decades of research have shown that computer technology in the classroom can enrich teaching and learning and boost student achievement, compared to teaching without such aids [1] Augmented Reality is well aligned with constructive learning notions, as learners can control their own learning and manipulate objects that are not real in augmented environment to derive

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 175–183, 2019.
https://doi.org/10.1007/978-3-030-35343-8_19

and acquire understanding and knowledge. It has been explored that AR abides by the primary tenets of constructivist learning theory. Augmented books resemble print books except that their pages have virtual graphics superimposed on them. They offer a broad perspective on the educational AR experience because the pages provide ideal images for AR visual tracking, and even young children know how to open and read books. In a sense, augmented books are digital versions of the familiar pop-ups, in which a 3D cardboard construction rises off the page as the reader opens the book. The virtual content can provide an animated scene that complements print content, and in some cases [2].

The reasons mentioned above, this study recognize the importance of computer classroom constructivist learning environment design. The researcher applied the analytical thinking, constructivist theory, cognitive theory, the augmented reality, the media attribution and symbols system used, textbook design and the specific context for the learning content synthesizing them as the framework for designing the constructivist augment reality book enhancing analytical thinking. Studies have reported increased student motivation, improved collaboration, knowledge construction, analytical thinking ability and enhanced computer classroom practices.

2 Literature Review

2.1 Augmented Reality (AR) Book

Augmented reality learning environment is a media that design based on theory to practice; coordination between the method: cognitive constructivist, social constructivist theory, cognitive theory, analytical thinking and the media and technology: media symbol system, media attribute as hypertext, hyper link, hyper media, and technology for learning (AR-technology) [3]. Accordingly, AR books have appeared as an attempt to apply AR to the e-Book format. AR books have enhanced the concept of books by creating interactive environment that incorporates animation, 3D graphics, and simulation [4]. Moreover, AR books are intriguing, thus prompting readers' motivation and immersion [5]. A wide variety of AR books ranges from those which enable readers to simply observe the augmented 3D objects to those which require readers to actively interact with the books [6].

2.2 Constructivist Learning Environment

Constructivism is a major theory in online learning that posits that knowledge is individually constructed by learners based on their interpretations of experiences in the world [7]. Jonassen [8] proposed what he called "Constructivist Learning Environments" (CLEs) as educational environments that were created for the purposes of independent learning through constructivism. In these situations, the instructor becomes the facilitator, guiding the learners through their knowledge building. Just like a player in a well-designed virtual simulation, the learner is the one in control in the constructivist learning environment.

3 Theoretical Framework

The theoretical framework was synthesized based on studying and analyzing the principles, theories, and related literature regarding design and development, cognitive theories, constructivist theories, the constructivist learning environment model, augmented reality (AR), media attribution, media symbol system, and analytical thinking. The theoretical framework showed five important theoretical foundations, which were as followed: (1) Contextual base, (2) Psychological base, (3) Pedagogies base, (4) Analytical thinking base, and (5) Media theory and Technologies base (see Fig. 1).

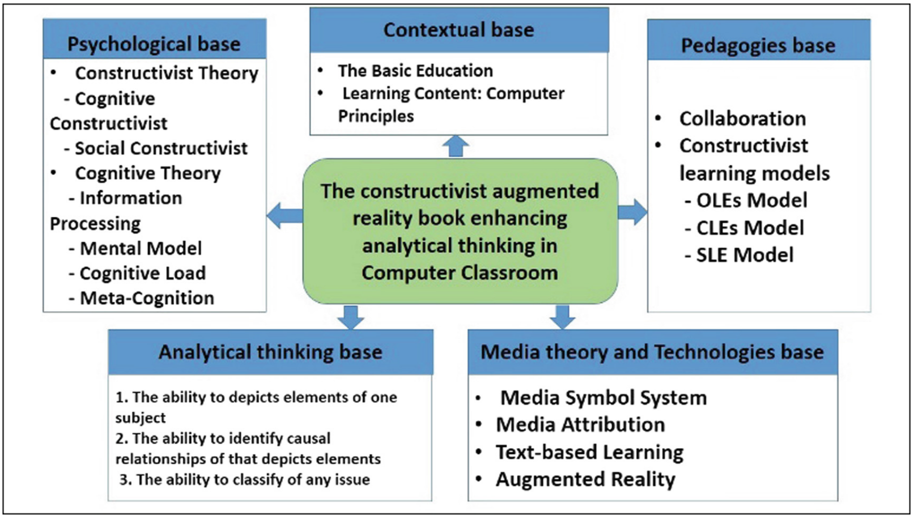


Fig. 1. Theoretical framework of the constructivist augmented reality book enhancing analytical thinking in computer classroom.

4 Method and Result

4.1 Target Group of the Study

The expert review for assessment the efficiency of constructivist augmented reality book were as follows: 3 content experts, 3 instructional designers, 3 augmented reality book designers and 3 measurement and evaluation experts, and 39 students, grade 3 student of Demonstration School, Khon Kaen University.

4.2 Research Design

The developmental research Type I [9] was employed in this study. Several methods were used such as document analysis, survey, and case study.

4.3 Research Instruments

The instruments in this study consisted of experimental instruments: constructivist augmented reality book enhancing analytical thinking and data collection instruments. Both were described below.

- The instrument for experiment included the constructivist augmented reality book enhancing analytical thinking. The process of the design and development were as follows: (1) examined the principles and theories, (2) synthesized the designing framework of the constructivist augmented reality book enhancing analytical thinking, (3) designed and developed the constructivist augmented reality book enhancing analytical thinking based on above mentioned designing framework, and (4) evaluated the efficiency of the constructivist augmented reality book enhancing analytical thinking.
- The instruments for data collection included the following: (1) the record form of document analysis, (2) the evaluation form for the experts, (3) the learners' opinionnaire toward the constructivist augmented reality book, and (4) The learners' analytical thinking tests.

4.4 Data Collection and Analysis

The researchers designed and developed the constructivist augmented reality book enhancing analytical thinking based on the above-mentioned framework and components. It was tried out. The quantitative and qualitative data were collected and analyzed in the following was:

- The expert reviews in several domains, such as learning content, media, instructional design, augmented reality book design, and measurement and evaluation experts. The data were collected by the researchers and analyzed through analytic description, interpretation and summarization.
- The learners' opinions toward the constructivist augmented reality book. The data were collected by the researchers and analyzed by analytic description, interpretation, and summarization.
- The analytical thinking tests. The quantitative data were collected and analyzed by descriptive statistics: mean, *S.D.*, and percentage. The qualitative data were collected and analyzed by analytic description, interpretation, and summarization.

4.5 Research Results

The design and development of the constructivist augmented reality book enhancing analytical thinking were as follows:

- The designing framework of constructivist augmented reality book enhancing analytical thinking was synthesized based on the mentioned theoretical framework which had the following details: (1) The activation of cognitive structure and analytical thinking were designed based on Enabling context [10] and Analytical thinking [11] as Problem base, (2) The supporting cognitive equilibrium was designed based on cognitive theories as Resources [10], (3) The enhancement in constructing knowledge and analytical thinking were designed based on both Social Constructivist [12] as Collaboration and Analytical thinking [8, 11] and Manipulating tool [10] as Analytical thinking training centre, and (4) The support and enhancement for constructing knowledge were designed as Scaffolding [10], and Coaching [8].

- Constructivist augmented reality book enhancing analytical thinking was produced based on the designing framework comprised of 6 components as follows: (1) Problem base, (2) Resources, (3) Collaboration, (4) Analytical thinking training centre, (5) Scaffolding, and (6) Coaching obtaining as description of each key element is shown in Table 1.

Table 1. The key elements and descriptions learning environment.

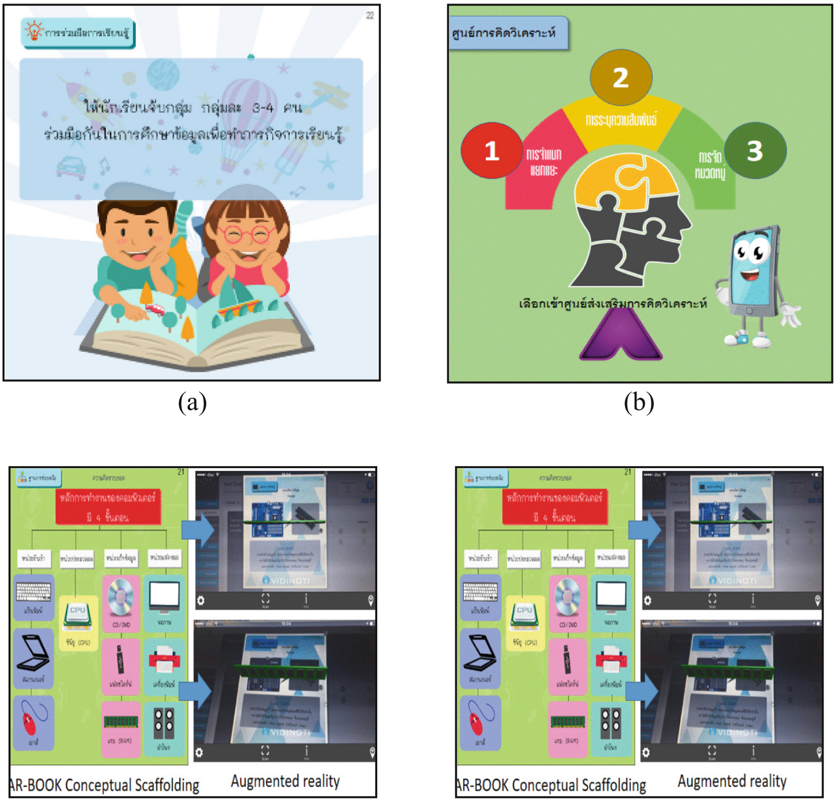
Key elements	Description
1. Problem base & Learning Task	It was shown Problem base for enhancing the learners to construct knowledge and analytical thinking learning tasks
2. Resources	It was shown Resources to provide just-in-time information to help learners comprehend and solve the problem
3. Collaboration	It was shown Collaboration for supporting the learners to share their experience with experts by using Facebook and Google Classroom for expanding their multiple perspectives
4. Analytical thinking training centre	It was shown Analytical thinking training centre for enhancing Analytical thinking [11]
5. Scaffolding	It was shown Scaffolding for enhancing students to solve problems, to learn and construct the knowledge by themselves
6. Coaching	It was shown Coaching by teachers and experts in learning content with computer principles with best practice

The constructivist augmented reality book enhancing analytical thinking was produced based on the designing framework (see Figs. 2 and 3).

- **The** efficiency of the constructivist augmented reality book enhancing analytical thinking was illustrated as the following: The experts' review which was found that the learning content, instructional design, and augmented reality book design, was appropriate detailed in Table 2.

(a) (b)

Fig. 2. Example design screen of (a) Problem base; (b) Resources References.



(a) (b)

(c) (d)

Fig. 3. Example design screen of (c) Collaboration; (d) Analytical thinking training centre (e) Scaffolding; (f) Coaching.

According to Table 2, the results of the assessment of the experts on the learning content (86%), the instructional design (80.83%), the constructivist augmented reality book enhancing analytical thinking 82%) and the total of the assessment of the experts was 81.53.

- **The** learners' opinions studies were learning contents, media design, and constructivist augmented reality book was appropriate, as well as the support knowledge construction and analytical thinking of learners detailed in Table 3.

According to Table 3, the results of the assessment of the learners' opinions studies on the learning content (88%), the media design (81.5%), the constructivist augmented reality book (82.83%) and the total of the learners' opinions studies was 82.71%.

Table 2. The efficiency of learning environment.

No.	List assessment	Results of the expert (Percentage)
Learning content		
1.	Appropriate learning content	86
Instructional design: The design elements of the constructivist augmented reality book		
2.	Problem base	80
3.	Resources	85
4.	Collaboration	80
5.	Analytical thinking training centre	82
6.	Scaffolding	79
7.	Coaching	79
		80.83
Comments about constructivist augmented reality book		
8.	The constructivist augmented reality book enhancing analytical thinking	82
	Total	81.53

Table 3. The learners' opinions studies.

No.	List assessment	Results of the expert (Percentage)
Learning content		
1.	Appropriate learning content	88
Media design		
2.	Functionality	82
3.	Reliability	82
4.	Usability	81
5.	Portability	81
		81.5
The design elements of the constructivist augmented reality book		
6.	Problem base	82
7.	Resources	86
8.	Collaboration	85
9.	Analytical thinking training centre	82
10.	Scaffolding	80
11.	Coaching	82
		82.83
	Total	82.71

- The Learners' analytical thinking was found that there were 70% (mean = 80.40, *S. D* = 0.22) of qualified the learners from analytical thinking test, and the protocol analysis and interviews was found that the learner's analytical thinking ability as follow (1) the learners can identify elements of computer principles, (2) the learners are able to identify a causal relationship to the use of computer principles, and (3) the learners are able to classification of the elements of the computer principles.

5 Conclusions

According to the above findings, the results of this study as shown above, may cause from instructional design: ID Theory. This is the instructional designs which are based on the principles and theory. It can be illustrated by the quality of the constructivist augmented reality book enhancing analytical thinking that assessed by expert review. The quality was shown in several aspects: the content is accurate and appropriate; Media were designed to support the knowledge construction and analytical thinking was based on learning theory. In addition, the constructivist augmented reality book in each of the components of such a problem base which provides the learners faced with the real-world problem and analytical thinking learning task. This can lead to the application of the knowledge in the daily life. Moreover, learners can use cognitive tools and game-based learning in Analytical thinking training centre for employing open-ended technology tools specific to their problem-based learning task area with game-based learning. Empirical evidence derived from learners, learning theories and principles that support the learners to be able to promote for analytical thinking in the computer classroom.

Acknowledgement. This work was supported by the Innovation and Cognitive Technology Research Center, Faculty of Education, and the Research and Technology Transfers Affairs Division, Khon Kaen University.

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Effect of Augmented Reality on Astronomical Observation Instruction

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Abstract. Knowledge about astronomy is an important part of natural science; however, students taking the course of observing the outer space and stars cannot efficiently engage in the activity that poor learning outcome results from the limits of time, place, weather, and flat teaching materials. Although simulation software or paper-based planispheres have been applied to support astronomy learning, students cannot clearly understand the three-dimensional nature of astronomical concepts. Recently, due to the rapid advancement of technology, augmented reality (AR) is applied more and more to education. With the support of AR, classrooms are provided with real-and-virtual-combined learning equipment for students to reach the goal of visualizing complicated space relationships and abstract conception. It seems to bring a new opportunity for astronomy learning. However, although there have been studies on applications of augmented reality, few of them are concerned about empirical investigation on astronomical observation. This study therefore aims to establish an augmented-reality learning system on mobile devices and compare the differences among learning aids of a paper-based planisphere, computer simulation, and augmented reality on cognitive learning achievement and stargazing skill on astronomical instruction. Three classes of elementary students, in total, 87 students, participated in this study. One class used augmented reality on mobile devices to conduct astronomical observation, another class used simulation, and the other class used paper-based planispheres. The results indicate that augmented reality was effective in improving astronomy knowledge and stargazing skill.

Keywords: Augmented reality · Astronomical observation · Stargazing · Elementary education

1 Introduction

Astronomical observation is a formal course in the elementary education in Taiwan including observation of the sun, moon, and stars. Therefore, the courses of astronomical observation are basic and important, at least in Taiwan. However, astronomical observation instruction is difficult to completely implement because it needs actual outdoor experience and observation which is limited by location and time in formal courses [1]. Especially for the course of stargazing, the difficulties encountered during the instruction include: (1) ideal star-observation time is at night. However, courses at

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 184–193, 2019.
https://doi.org/10.1007/978-3-030-35343-8_20

night are not easy to implement for the general class time; (2) it is affected by geographical location and weather. There may be no stars visible in places with copious amounts of light pollution or rainy and cloudy weather; (3) The concept of space is difficult to understand, and the relative locations between the planet and the earth are often confused; (4) there are insufficient qualified teachers. Many science teachers have no astronomy-related expertise; and (5) more manpower is necessary to ensure the safety of students if stargazing courses are conducted at night time. In sum, the course of stargazing has many restrictions. Therefore, additional aids are needed to facilitate the instruction.

At present, most of the astronomical instruction uses the paper-based planispheres (see Fig. 1) as an auxiliary tool. However, the actual use of the paper-based planisphere in teaching also encounters many difficulties, such as the light and the concept of 3-dimensional space transfer. To solve these problems, some studies used computer simulation to enhance astronomy education (e.g. [2, 3]). However, the learning material is displayed on a 2-dimensional screen, which may make it difficult for the students to transfer the learned operational experience to the real situation [1]. Therefore, it is necessary to seek more effective learning aids.

On the other hand, more and more studies applied augmented reality (AR) in education [4–6]. AR can be combined virtual learning environment with the real teaching situation to visualize complex spatial relationships and abstract concepts [7]. That is, AR can achieve a seamless integration between real and virtual environments [8]. The past studies also pointed out that AR can improve learning motivation [9, 10] and learning outcomes [11, 12], and also enhance the concept of space [13]. Hence, AR seems to be a very promising emerging technology for learning [14].

Therefore, this study expects to use technology of augmented reality to solve the problems faced by the above-mentioned astronomical observation. Although there are many studies on the application of AR in learning, few studies focus on astronomical observation. Therefore, this study developed an augmented reality-assisted astronomical learning system and compared the differences among learning aids of paper-based planisphere, computer simulation, and AR on cognitive learning achievement and stargazing skill. That is, the research questions in this study are as follows.

1. Whether students' cognitive learning achievement among learning aids of paper-based planisphere, computer simulation, and artificial reality are different; and
2. Whether students' stargazing skill among learning aids of paper-based planisphere, computer simulation, and artificial reality are different.

2 Literature Review

2.1 Augmented Reality in Education

The first augmented reality system was completed by Sutherland and his students in 1968 [15]. From a technical point of view, augmented reality has three main elements: (1) must combine virtual and reality. (2) be able to provide instant interaction. (3) be able to locate in space. In addition, Butchart [16] divides augmented reality into three types: marker-based AR, markerless AR, and location-based, depending on the identification method.

The marker-based augmented reality uses artificially crafted labels (and possibly QR codes) to aid in the identification of objects, while non-labeled ARs identify non-manual real-world objects (such as books, posters, or landmarks). Conversely, the location-oriented AR is based on sensors attached to a device, such as digital compass, three-axis acceleration sensor, gyroscope, geolocation system, etc., to track and collect information about the geographical location, to identify the natural environment.

In recent years, with the maturity of software and hardware, the application of augmented reality has become more and more extensive. It has appeared in the fields of commerce, architecture, military and science, medical, entertainment, education [14], and games [5, 17]. In terms of education, AR were applied in English learning [18, 19] health education [4, 20], marine education [21], math [22], social science [23], and astronomy education [1, 6, 24]. Compared with other subjects, studies focus on astronomical observation are few.

2.2 Effect of Augmented Reality on Learning

Situational learning theory advocates that learning should be a product of the interaction between learners and situations, emphasizing that learning should be constructed in real activities. Only through their own observations and actual actions, learners can construct meaningful ones [25]. Meaningful knowledge is learned through interaction with real-life situations [14], and learners learn through interaction with real situations. Augmented reality allows real and virtual environments to coexist. It provides educational experiences for learners, including seamless interaction between real and virtual environments, and the ability to seamlessly transform between real and virtual contexts [8].

Due to the above combination of real and virtual environment characteristics, many scholars believe that augmented reality has brought many positive effects to learning. For example, some past studies pointed out that augmented reality can enhance the motivation [9, 10] and interest of learning. In terms of knowledge learning, there are many studies that indicate that augmented reality can enhance learning achievement [11]. Sayed et al. [12] emphasize that augmented reality can help learners gain knowledge in a more efficient way than other computer-assisted learning methods. In sum, most past studies showed AR can enhance learning. However, there is few evidences whether AR can enhance astronomical knowledge and stargazing skill. Therefore, it needs further examination.

3 Method

3.1 Participant and Experimental Design

The experimental design aims to compare learners who are supported by different instructional aids: paper-based planisphere, computer simulation, and AR. A nonequivalent pre-test-post-test based on a quasi-experimental design was performed. In total, 87 primary school students were recruited to join one-day winter camps for free.

The students were assigned to the planisphere-assisted learning group, the computer simulation-assisted learning group, and the augmented reality-assisted learning group by cluster random sampling. The number of each group was 30, 28 and 29 respectively.

Every course is carried out in one day, from 1:30 pm to 9:30 pm. After pre-test, each group carried out a six-hour astronomical instruction with the same content, and with the same teacher. The only difference was that the teaching aids used were different. The post-test was carried out immediately after the experiment. The content included the paper-and-pencil achievement test which was the same as pre-test, and the practical stargazing target test.

3.2 Research Tools

Cognitive Learning Achievement Test
The cognitive learning achievement test is to test students' astronomical knowledge. This test is based on the curium guidance of Natural and Living Science and Technology issued by the Ministry of Education. It was revised by 3 experts in the field of Astronomy. The test contains 10 four-choice questions. The same questions are used in the pre-test and the post-test.

Stargazing Targets Test
For the stargazing target test, students were instructed to identify 3 target stars. Students were tested one by one with the teacher. One to 3 points was given for locating a correct target within 10 min using the learning aid which they used in their group.

Instructional Aids
In total, there were three groups in this experiment. The students in the planisphere-assisted learning group used a paper-based planisphere and taught in a traditional classroom.

The students in the computer simulation-assisted learning group used an astronomical simulation software, namely Stellarium (see Fig. 2), which is run on PCs. The students underwent their course in a computer lab.

The students in the augmented reality-assisted learning group used an astronomical learning system which is run on a tablet PC or smartphone backed by Android operating system. The system consists of two parts: instructional module (see Fig. 3) and AR-based armillary-sphere module (see Fig. 4). In the instructional module, students can practically operate to learn astronomical knowledge. In AR-based armillary-sphere module, students can use it to point out real constellations in outdoors sky. In the augmented reality-assisted learning group, students learned astronomy with a personal tablet PC.

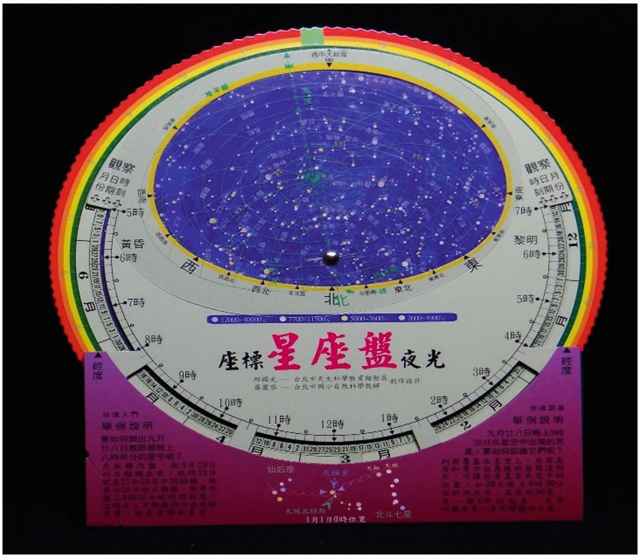

Fig. 1. Paper-based planisphere.

Fig. 2. Screenshot of Stellarium software.

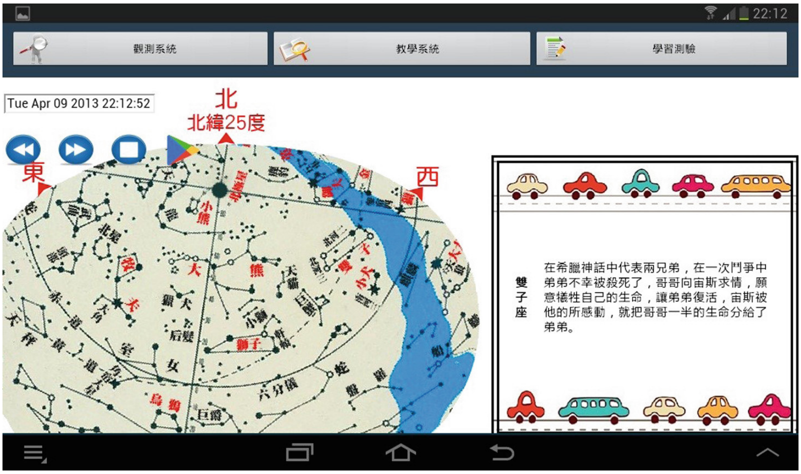

Fig. 3. Instructional screen in the astronomical learning system.

Fig. 4. AR-base16d armillary-sphere screen in the astronomical learning system.

4 Results

This study used IBM SPSS Statistics Base 22.0 to analyze the results. One-way analysis of covariance (ANCOVA) was examined on the cognitive learning achievement and practical stargazing among the three groups. In terms of cognitive learning, to conduct one-way ANCOVA, the pre-test score was regarded as a covariate; the group was an independent variable, and the post-test scores on cognitive learning achievement were dependent variables. In one-way ANCOVA, the first step was to analyze the homogeneity of the regression coefficients. The F test results ($F = 2.923$, $p > .05$) did not reach significance, revealing that the regression slopes of the three groups are equivalent, confirming the assumed homogeneity of coefficients.

The ANCOVA result for the cognitive learning (see Tables 1 and 2) did reach significance ($F = 4.818$, $p = .010 < 0.05$) after an adjustment was made for the dependent effect with respect to the covariate. This result shows that the mean scores varied significantly among the three groups. Therefore, a post-hoc multiple comparison was performed, and its results revealed that the cognitive learning achievement in the AR group (adjusted $M = 10.640$, $SD = 0.340$) was significantly better than that of the computer simulation group (adjusted $M = 9.223$, $SD = 0.357$) and paper-based planisphere group (adjusted $M = 9.433$, $SD = 0.351$). However, learning achievement between the computer simulation group and paper-based planisphere group was not significantly different.

Table 1. Pretest means, adjusted posttest means, standard deviations for cognitive learning.

Variable (Instruction condition)	*N*	Pretest		Posttest	
		M	*SD*	*M*	*SD*
Artificial reality	30	3.70	1.601	10.640	0.340
Computer simulation	28	3.82	1.806	9.223	0.357
Paper-based planisphere	29	3.66	1.396	9.433	0.351

Table 2. Analysis of covariance for cognitive learning with pretest test as covariate.

Source	*SS*	*df*	*MS*	*F*	*P*	*Partial* η^2
Instruction condition	34.272	2	17.186	4.818	.010	.104
Error	296.051	83	3.567			

One-way ANCOVA was also analyzed stargazing skill. The ANCOVA result for the stargazing skill (see Tables 3 and 4) revealed that it reached significance ($F = 6.317$, $p = .003 < 0.05$) after an adjustment was made for the dependent effect with respect to the covariate. Therefore, a post-hoc multiple comparison was performed, and its results revealed that the stargazing target in the AR group (adjusted $M = 7.169$, $SD = 0.318$) was significantly better than that of the computer simulation group (adjusted $M = 5.919$, $SD = 0.330$) and paper-based planisphere group (adjusted $M = 5.662$, $SD = 0.324$). But, stargazing skill between the computer simulation group and paper-based planisphere group was not significantly different.

Table 3. Pretest means, adjusted posttest means, standard deviations for stargazing skill.

Variable (Instruction condition)	*N*	Pretest		Posttest	
		M	*SD*	*M*	*SD*
Artificial reality	30	3.70	1.601	7.169	0.318
Computer simulation	28	3.82	1.806	5.919	0.330
Paper-based planisphere	29	3.66	1.396	5.662	0.324

Table 4. Analysis of covariance for stargazing skill with pretest test as covariate.

Source	*SS*	*df*	*MS*	*F*	*P*	*Partial* η^2
Instruction condition	38.417	2	19.209	6.317	.003	.132
Error	252.406	83	3.041			

5 Discussions and Conclusions

This study developed an astronomical learning system which is run at tablet PC or smartphone with Android operating system. The system provides two parts: instructional module and AR-based armillary-sphere module. Moreover, the study also examined the differences in terms of cognition and practical stargazing skill between the instructional aids of paper-based planisphere, computer simulation, and AR. The results revealed that students' cognitive learning achievement and practical stargazing skill in the AR group is better than that in the computer simulation group and paper-based planisphere group. Nevertheless, in terms of cognitive learning achievement and stargazing skill, there were no significant differences between the computer simulation group and paper-based planisphere group. The results are similar to the past studies (e.g. [1]). In sum, augmented reality technology can enhance astronomical learning achievement and practical stargazing skill. Therefore, AR is very promising emerging technology, which is suitable to be applied in astronomical education.

Although this study argued that AR can enhance learning achievement and skill, there are some learners' characteristics may affect learning performance using AR, such as learning style [14]. Moreover, past study argued that AR may cause a higher cognitive load because it provides a lot of information, and many technology devices need to operate [7]. Accordingly, exploring whether there are some negative effects for AR-aided learning in astronomical education, such as cognitive load, is the future work.

Acknowledgements. The authors would like to thank the Ministry of Science and Technology of the Republic of China, Taiwan for financially supporting this research under Contract No. MOST 105-2511-S-259 -004 -MY3.

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Enhanced Learning of Jazz Chords with a Projector Based Piano Keyboard Augmentation

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Abstract. Learning jazz piano is considered technically difficult. Most people cannot afford private piano tuition and there are many freely available video tutorials on the Internet. This study identified a set of challenging topics associated with learning jazz piano based on popular YouTube jazz piano tutorials. The results suggest that learners are struggling to understand the construction of complex chords in the 12 keys. Most tutorial videos show two parallel keyboards, one physical with the real hands and one virtual keyboard, which the viewers must map onto their own keyboard. Based on these results a series of visualization approaches were explored through a low-fi prototype by augmenting the physical piano keyboard with voicing instructions using a projector.

Keywords: Augmented reality · Projection · Music · Piano · Jazz · Chord voicing

1 Introduction

Judging from the large number of tutorials available on the Internet, the learning of jazz and especially jazz piano is a popular undertaking. Unlike traditional popular music and classical music, jazz is known to be less bound to the way music should be performed. Often a jazz musician will only use lead sheet music to get a rough indication of the tune and its chord structure or simply play by ear. In jazz, more of the decisions on how a piece of music is played is left to the musician, and jazz is thus often associated with improvisations. In contrast, with classical music the musician simply follows the detailed instructions outlined in the sheet music.

With increased freedom and responsibility for how a piece of music is played, the player needs to understand the basic system of music that determines what will sound right in each context. In this study, we explored the content of online jazz tutorials to identify the topics that are capturing the main interest of jazz piano learners and teachers. Our results suggest that how to construct various chords is a key topic. The construction of chords involves several important decisions that greatly affect how the result sounds. Factors include the type of chords (major, minor, dominant, diminished, extended, suspended), which upper extensions (7ths, 9ths, 11ths and or 13ths) and how these should be voiced, i.e., where these components should be played, which

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 194–203, 2019.
https://doi.org/10.1007/978-3-030-35343-8_21

inversions to use (the order of the components) and fingering (mostly affecting chord transitions). In addition, the physical realization of a given chord on the keyboard depends on the key in which the chord is played.

A trained pianist should have internalized these structures and produce such chords instinctively without hesitation as part of the muscle memory. To get to this level much practice is needed. In order to get started with the right practice, the music students need to understand the space of valid decisions.

Traditionally, jazz piano was taught on a one-to-one basis with the guidance of an experienced musician. However, most hobby music students are unable to afford one-to-one tuition and some schools are experiencing budget cuts [1]. The Internet and online video services such as YouTube have made jazz learning much more accessible. The structure of a typical instruction video is the explanation of a given concept with the teachers' own anecdotes which can be important for learning. A common trend for such videos is to divide the viewing area into two where the bottom part shows the teacher's physical keyboard and the teacher's hands from above, while the top part shows a virtual keyboard with the depressed keys highlighted. Some tutorials also contain live sheet music. This makes it easier for students to see all the keys that are depicted simultaneously, which otherwise may be obstructed by other parts of the hands. The videos also often contain additional annotations such as chord names and textual explanations. Clearly, such videos can be paused, played again, and slowed down. However, a video is a passive medium analogous to reading. Viewers must translate what they see in the video to their own keyboard. This is easy for simple tunes and chords but becomes more challenging with more complex structures.

The goal of this work was to make the jazz piano learning process more immersive and interactive. Instead of having to look at the chord information on a screen and then reconstruct the structures on the physical keyboard, we augmented the physical keyboard with the chord structures directly. In addition to augmenting the keyboard with specific chord structures, we explored ways of visualizing the valid chord space on the keyboard using sketches [2]. The purpose was to train the students' ability to construct their own voicings. Rhythm [3] is not addressed herein.

2 Related Work

The idea of augmenting physical piano keyboards and other instruments such as the Chinese Guqin [4] is not new. There are even commercial products such as Casio's LK-280 keyboard with lit up keys to help learn the piano. There are also patents that describe similar ideas [5]. Still, augmentation is often associated with wearable display that superimposes virtual imagery on top of the physical worlds [6]. Trujano, Kahn and Maes [7] implemented a learning system for HoloLens where the learners wear the head-mounted AR-display. Their system includes a piano roll system where the notes of a tune appear in a stream training both the temporal and spatial aspects of music. They also show chords structures and extra functions such as augmented visualizations of mistakes over time. Unfortunately, current head-mounted AR-displays are relatively expensive and inaccessible. More importantly, the field of view is small which limits the user experience. A somewhat more stripped implementation also based on

HoloLens was reported one year earlier by Hackl and Anthes [8]. A system employing the Epson BT300 augmented reality headset has been reported [9]. Birhanu and Rank [10] implemented a HoloLens piano tutoring system using an "in the air" virtual piano. Liang et al. [11] implemented an "in the air" virtual piano with the focus on a visual system for detecting the finger motions.

Several systems have experimented with projected augmentation where an overhead projector is placed above the piano keyboard allowing specific keys to be lit up in various colors. It is argued that such setups lead to more rapid learning as it eliminates learning sheet music. The area behind the keyboard can be covered in white allowing this space to be used as an extra information display. Rogers et al. [12] implemented a projector-based system with a piano roll that incorporated various additional information such as fingering information using color coding. In a related project, Weing et al. [13] implemented such a system for right hand practice using piano roll visualizations as well as projected menus associated with the piano pedals. Similar approaches with variations including games for accelerated learning have also been reported by Raymaekers et al. [14]. Chiang and Sun [15] implemented a virtual projected piano, which detects keypresses with a camera. Their system has a training mode to guide the user towards the right keys on the keyboard. Instead of highlighting keys, Gerry, Dahl and Serafin [16] overlay the videos of the teacher playing on top of the student's hands. Their system was implemented using a magic leap headset.

A totally different approach is to project a performer's hands directly on the keyboard while displaying the upper body of the performer in front [17–19], or support for remote learning by projecting a mirror image of the keyboard with the teacher's hand behind the keyboard [20]. The idea is that the student learns by playing along by copying the movements of the master. This approach is also used in other domains to visualize the craft of an expert [21]. Nemoto and Umezu reported a similar approach where they played back a mirrored version of a video, slowing the teacher playing behind the piano keyboard [22]. The same research group also explored learning through animated characters projected onto the top of the piano keyboard [23].

Most work on augmented reality for piano training focuses on visual augmentations. Some work has also addressed the sense of touch by incorporating haptic stimuli allowing the student to feel the movements of the teachers. For instance, using gloves with sensors and vibrators [24]. Fujii et al. [25] experimented using haptic feedback to guide the hands of the student as an expert while learning to play instruments. Kallionpää and Gasselseder [26] discussed the augmentation of the audio that is possible with computer technology. Augmented reality has also been used at a different level such as enhancing printed text [27] and songbooks [28].

One related approach includes Piano Genie, a system where novices are empowered to improvise on a piano using a controller with eight buttons [29]. The button presses are automatically translated into piano keypresses that musically make the most sense. Their system was built using a neural network. Other systems encourage learning by playing along with automatic comping, such as GimmeDaBlues app [30].

There have also been numerous reported efforts on visualization of music. Snydal and Hearst [31] visualized jazz improvisations and presented two types of views, one visualizing the melodic landscape and another showing the harmonic palettes used. The visualizations allow the different improvisation styles of different musicians to be compared. Chiua et al. [32] visualized music using color where the keys were organized into a circle of thirds, i.e., a circle of an octave with three semitones between the tones assigned the colors of the color wheel. Pleasant sounding transitions are seen as gradual changes in color. Bergstrøm and Karahalios [33] implemented a system for visualizing structures in music by the means of Tonnetz which is a two-dimensional triangular representation of tonal space.

3 Method

3.1 Qualitative Video Study

To identify key issues faced by jazz piano learners, jazz piano tutorials on YouTube were investigated over a period of one month. The videos were reviewed for the content explained and the methods used to communicate the ideas. Higher weights were given to issues echoed in videos by several YouTube-teachers and only issues addressed by more than one teacher were included. The approach was ad-hoc as it is difficult to review YouTube videos in a systematic manner as these videos are not systematically categorized according to structure. However, as the YouTube search engine tends to return videos with many views it is likely that the findings are representative of the overall trends. Concerning content, the videos vary greatly in quality. Frequently downloaded videos were considered likely to be more correct as they are trusted and "quality assured" by more viewers.

3.2 Design Cases

Based on the findings from the video study, a set of cases was selected for further exploration through a design phase. The design phase involved ideation around alternative ways to visualize the content using keyboard augmentation based on a setup with a projector and a physical keyboard. A simple low-fidelity prototype was realized using manually generated images that were projected onto the keyboard. These images were generated by first obtaining measurements of the keys of the keyboard based on an overhead image. Next, augmentations were created using various colors on a black background as the black regions are not projected while all the non-black regions are projected. The intensity of the colors in the image controls the intensity of the augmentation.

4 Results

4.1 Key Issues in Jazz Piano Learning

The results of the video analysis show that most video tutorials on jazz piano employ overhead video of the hands on a physical together with a virtual keyboard with pressed keys above. Many of these videos also contained additional information superimposed on the video such as textual explanations, chord names, tonal information and voicing information. Some chord information was inserted manually, and some appear to be based on automatic chord recognition systems. Clearly, the manual chord labelling was generally easier to understand and clearer than the automatically generated chord names which sometimes did not match the explanations of the teacher. One key aspect of jazz piano is the notion of ambiguous chords which can be interpreted as several types of chords. Some videos only showed the teacher's hands from above. These videos were also useful, but some finger movements can be hard to observe, especially with complex chords around the black keys. A few videos showed the keyboard from other angles, making it harder to study the motions of the keys. In such situations the verbal commentary and in-video annotations are highly useful.

The videos revealed that chord voicing is a difficult and important area for learners of jazz piano. Many videos cover 7th, 9th, 11th and 13th that are used to create dissonance and ambiguity and what several teachers refer to as "modern sounding". Many videos attempt to explain how to construct higher order chords and what choices that make these chords sound good, i.e., how to spread the chords across two hands and using larger intervals in the left hand. Chord inversions and the dropping of notes (moving notes around octaves) are also a recurring topic of high importance. Another topic is the role of the tonic (root) and guide tones (the 3rd and the 7th) which are used to communicate if the chord is a major or a minor. In fact, having great freedom in how to voice the chords is something that may be overwhelming for learners. Some videos therefore explain tricks such as slash chords and stacked chords (e.g., stacked fifths which are easy to play and that sound sophisticated). Several videos also explain "standard" voicings that sound good, including So what chords, Kenny Barron voicings, Herbie Hancock voicings and Thelonious Monk voicings. Several videos encourage the practice of these chords in the 12 keys with suggested practice drills. For example, playing the chords across the 12 keys in increasing or decreasing order, or around the circle of fourths clockwise or anticlockwise.

Another much-addressed topic is chord progressions. The tutorials illustrate chord progressions such as the popular ii-V-I progressions. Another topic is the circle of fifths. Moreover, minimizing the number of finger movements between chords in the progression is another key concept. Another frequent topic is the use of chords to play melody lines by the means of four-way close, locked-hands and drop-2. All these techniques are based on having the melody lines as the top note in the chord and alternating with I and V chords across the scale.

In terms of melodic improvisation, several tutorials are addressing mode, which is musical scales of "valid notes" in each musical context (Ionian, Dorian, Phrygian, Lydian, Mixolydian, Aeolian, Locrian). Note that the topic of jazz piano is vast and that the topics mentioned only represent the most noticeable topics uncovered.

4.2 Design Cases

The simplest visualizations show specific chords. Figure 1 shows an example of a Kenny Barron voicing which comprises two fifths in the left and the right hands. Students with large hands can practice the entire chord directly, while students with small hands can use the highlighted areas as targets for arpeggiating the chord (playing the six notes in sequence). Figure 2 shows locked-hands with a drop-2 for playing a melody note. These visualizations are indeed not novel as they make use of similar ideas as what is demonstrated in other projection based piano tutors [12–14].

Fig. 1. A D11 minor Kenny Barron voicing. Note that two colors are used to differentiate the hands (green left and blue right). (Color figure online)

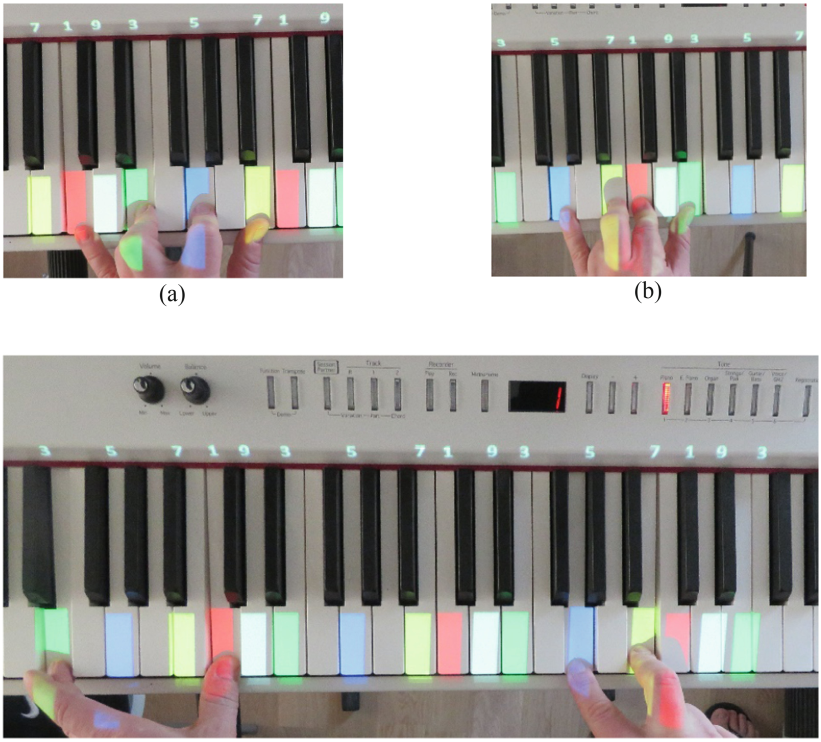
Although jazz piano, especially cocktail style jazz piano makes use of the entire keyboard, most jazz chords make use of the middle part and lower part of the piano for the best sounding chords. We therefore explored to use the upper part of the piano for controlling the tuition where a set of control keys is augmented with labels to indicate function and state. Figure 2 also shows how the user can alter the key of the chord tuition, if it is a major, minor, dominant or diminished, and voicing to include in the visualizations. In this example the locked hand chord with drop 2 is moved from the key of C to the key of Eb minor. Obviously, these controls can be changed dynamically to match the given mode of instruction. This means that even a simple MIDI keyboard without control buttons can be used to control the tuition directly without having to use the computer interface. Hence, the focus remains on the piano keyboard.

However, the strength of the approach is the ability to visualize the musicians' freedom. Figure 3 shows how all the keys of a keyboard that make up valid C9 chords are highlighted and how the learner can intuitively experiment with various inversions and moving of notes around. Figure 3 shows how colors can be used to highlight the various degrees of a 9$^{\text{th}}$ chord. Annotations are augmented on the keyboard frame of the keyboard to help the learner, that is, chord name, note names and scale degrees.

Augmented visualizations can also be used to help learners understand smooth chord transitions. One rule-of-thumb is to select chord voicings in chord progressions that result in the minimum number of finger movements. Figure 4 illustrates one possible chord progression from C9 to F9 (one step on the circle of fifths) with the common keys in white, the unique C notes in green and the unique F notes in red.

Figure 5 shows a chord explanation mode where the student plays a set of tones and the possible chords these tones can be interpreted as displayed. The various physical keys are used to show the keys this chord can be used for, while the list of types of chords functions as a histogram. By selecting a specific chord using the control keys, the additional notes needed to make a full chord are displayed. Note that the information projected onto the black key does not show very well.

Fig. 2. Controlling the tuition with keys. A locked-hands drop-2 in the key of E.



(a) (b)

(c)

Fig. 3. (a) A C major 7 in first inversion played in the space of valid notes in a C9 major chord, (b) a C major 7 in the 3rd inversion, (c) A C major 7 played with the root and the third in the left hand and the fifth and seventh in the right hand. (Color figure online)

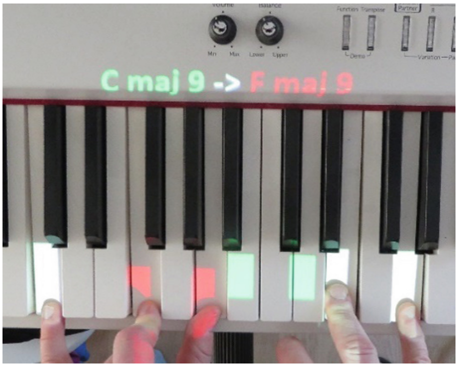


Fig. 4. Chord progression from C major 9 to F major 9. (Color figure online)

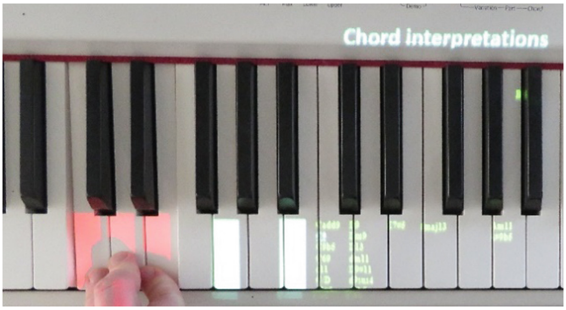


Fig. 5. Investigating ambiguous chords. The user enters a chord with three consecutive tones (C, D, E), which can be interpreted as Cadd9, C9, C9b5, D9, Dm9, Cmaj9, E7#5, D13, C69, dm11, am11, c11, D9#11, C/D, d9sus4, d9b5, a#9b5, c9#5, d11, cmaj13, fmaj13 and Bb9b5.

5 Conclusions

The learning of spatial jazz piano chord structures was addressed. A projector was used to augment the physical keyboard with chord voicing information. In addition to fixed chord voicings, we explored visualizing the space of valid chords to train on-the-fly chord voicings. Future work involves improving the interactivity by connecting the physical keyboard (if it has a MIDI or USB interface) to the music tutorial system allowing the system to respond to the student's actual keypresses with feedback in real-time. Moreover, usability assessments of the system as well as measuring potential learning effects should be conducted.

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Computational Thinking in Education

Improving Programming Education Quality with Automatic Grading System

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Abstract. As the rapid growth of information technology, the demand for proficiency in software programming skyrockets. Compared to teaching with slides traditionally, hands-on programming training is more beneficial and practical. However, it is exhausting and time-consuming for educators to grade all assignments in person. Besides, students may not get feedback immediately to correct their wrong conceptions. Therefore, an automatic grading system is required to grade and send feedback to students. Based on an existing continuous integration system, which checks whether new programs behave as expected, we develop a set of course management tools and deploy an automatic grading system in this paper. Our system requires a server to run and test the programs. However, the server is susceptible to being compromised by hackers. Therefore, how we protect sensitive data and prevent malicious network traffic are demonstrated in this paper as well. The tools were applied in an Android application development course with 140 students enrolled. Around 72% of the students indicate the automatic grading system is beneficial to their learning.

Keywords: Android · Continuous integration · Programming education · Software design

1 Introduction

As the rapid growth of information technology, the demand for proficiency in software programming skyrockets. Compared to teaching with slides traditionally, hands-on programming training is more beneficial and practical. For example, students are able to get acquainted with development tools and consider problems more deeply during the course of hands-on programming. Besides, as the saying goes, “practice makes perfect”. Students can gain precious experience after troubleshooting problems. Unfortunately, the number of students is much more than that of educators in most cases, which in turn makes educators be overwhelmed with the heavy workload. Especially for an Android application development course, each build takes a few minutes. Building all Android projects to grade students’ assignments is extremely time-consuming. Students cannot obtain feedback in a short time if their assignments are not reviewed immediately. What’s worse, conceptions in the class are coherent mostly. If educators are not able to correct students’ wrong conceptions, it is likely that students will struggle to keep up with the class. Therefore, there are still lots of room

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 207–215, 2019.
https://doi.org/10.1007/978-3-030-35343-8_22

for improvement on training approaches of hands-on programming, for instance, how to effectively track learning status of students and give immediate feedback to them.

In order to track learning status of students, there are some cases that the educators apply version control tools such as Git [4] to the hands-on programming courses, and ask the students to upload their source codes to the source-code-hosting facility such as GitHub or SourceForge [3, 5, 10]. This approach not only helps the educators manage students' assignments more easily but also help the students familiarize conceptions of the version control and share their projects with others. Nowadays, GitHub has launched ClassRoom service, which allows educators to establish associations between students and their GitHub accounts [8]. Besides, ClassRoom provides a convenient way to download all projects in single click as well. However, we found the following problems during a trial of ClassRoom. First, importing the starter codes sometimes fails, which was reported and discussed before. This situation implies that GitHub ClassRoom is still unstable. Second, ClassRoom imports all branches from the starter repository, which forces educators to place questions and answers of an assignment in separate repositories instead of in separate branches. Otherwise, Students are able to view the answer branch, which is imported along with the question branch. Storing questions and answers in different repositories may also produce redundant and messy codes, which are not easy to organize. Last, after educators update some files in the starter repository, the modifications are not synchronized to students' repositories. This limitation hinders educators in adding or modifying questions, which means that ClassRoom is not flexible enough to meet the update requirements. Given the three problems mentioned above, how to improve programming hands-on courses requires more studies.

Continuous integration plays a significant role for enterprises and open source software communities of today [6, 12, 13]. After a software developer pushing a new commit to the source-code-hosting facility, the continuous integration system will build and check if there is any problem automatically, which assists the developer to find out bugs as soon as possible. Hence if we can apply the continuous integration to the hands-on programming courses, the students will be able to realize and correct their mistakes in the assignments according to the error messages in the build logs. There are plenty of continuous integration platforms nowadays such as Jenkins, Travis, Circle CI and so on [20]. Among them, Travis has built the GitHub App and sold it in the GitHub Market. That makes the workflow automation process of Travis easier. Furthermore, Travis supports the Google App Engine deployment, which allows educators to get rid of difficulties in setting up a server to run continuous integration system [11]. After applying for an educator discount, educators are able to create private repositories under the organization and use Travis for free [19]. On the basis of the reasons we mentioned above, we think Travis is highly suitable to serve as the grading platform for programming courses.

Since the technique for applying continuous integration to the software hands-on programming is still incomplete, we develop a set of course management tools, consisting of `CourseManager.py`, `result_collector.py` and `grade.py`, based on an existing continuous integration system to make assignment management easier. (The `.py` extension means the tools are written in Python language which is supported by most operating systems nowadays.) Besides, educators need to connect servers or devices outside Travis sometimes. For example, we speed up builds in Travis by using an external Android emulator instead of creating a new one in Travis for each build. However, it is dangerous to expose a server to the Internet without any defense mechanism. The server is susceptible to be attacked [7]. Therefore, we will demonstrate an example to protect sensitive data and block malicious network traffic in this paper.

The remainder of the paper is organized as follows. In Sect. 2, we take an Android course for example and give an overview of our system architecture. In Sect. 3, details of the system are discussed along with figures. In terms of system stability, security issues concerning the system are described in Sect. 4. In Sect. 5, opinions of students who used our system in an Android application development course are showed. Finally, Sect. 6 concludes our paper and lists some future works.

2 System Architecture

2.1 Use Case of an Android Course

Figure 1 illustrates a use case diagram of an Android course. First of all, a student pushes a new commit to GitHub. GitHub then send a notification to the server though the webhook along with information including a list of modified files, commit hash, commit message, etc. [9]. After receiving the notification, the server checks if the student modifies some sensitive files such as the `.travis.yml` and update the cheating records to the database. At the same time, Travis pulls the new commit from GitHub and start to build according to the settings defined in `.travis.yml`. Eventually, Travis sends the result of the build to the server, and then the result is saved in a Sqlite database. Therefore, educators are able to track status of students' assignments whenever they need.

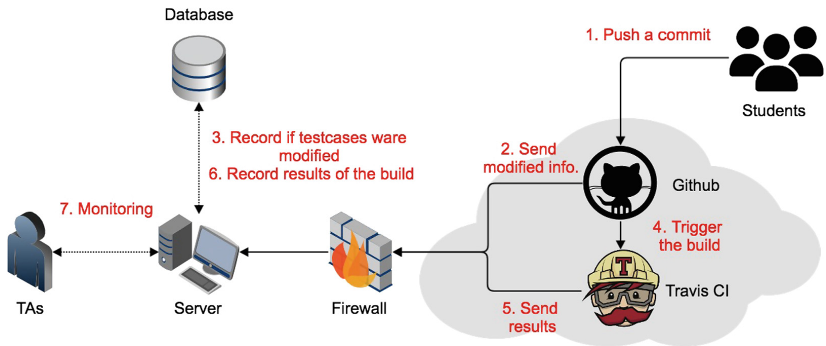

Fig. 1. Use case diagram of an Android course

2.2 Workflow

Figure 2 shows the workflow of the assignment management. First, educators create a repository for the starter codes and add testcases, which are the programs used to check whether students' programs correct or not, to the repository. Afterwards, educators edit `.travis.yml` and `testcases.yml` so that Travis and the server can build the project and record the result respectively. With the CourseManager.py, educators can execute a series of commands such as creating students' repositories, importing starter codes (copy all files from the default branch of the starter repository to the students' repositories) and inviting students as collaborators. If there is any error in testcases, educators can push new commits to correct the error with CourseManager.py as well, and the modifications will be synchronized to the students' repositories. In the end of school term, scores of each assignment can be exported from the database with another tool named `grade.py`, which prevents educators from grading all assignments manually.

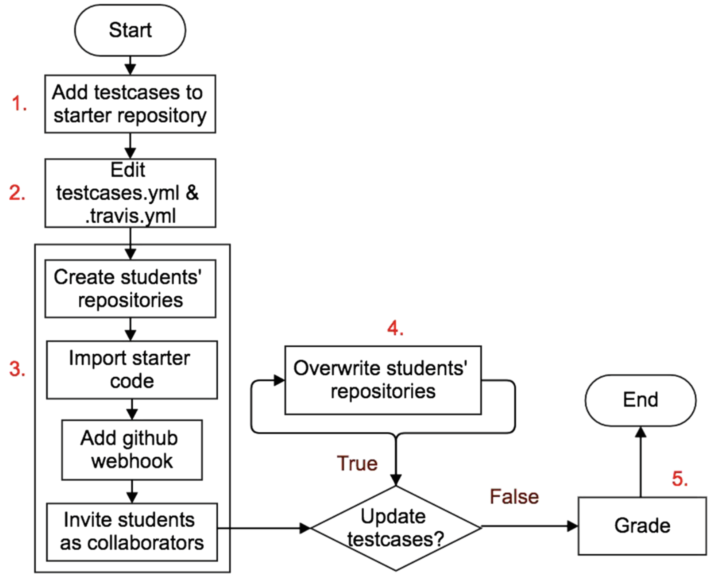

Fig. 2. Workflow of the assignment management

3 Details in Workflow of Assignment Management

In this section, we describe the details of each step in Fig. 2 in sequence.

3.1 Add Testcases to the Starter Repository

Testcases are the programs which are used to check if there is any logic error in students' assignments. We can classify testcases into two categories: unit test and user interface (UI) test. The former makes sure a section in the program generates expected outputs according to corresponding input arguments. For example, We can program a unit test, `test_add()`, to verify whether the function, `add(a, b)`, returns the summation of `a` and `b` correctly. The latter ensures components in the screen react correctly when a user interacts with them. For example, after a user clicking a button on the screen, an app should be launched. Testing libraries vary from a programming language to another. Take Android for instance, testing libraries for the unit test include Junit [16] and Robolectric [15]. The former aim to test the framework of java and logic of functions. The latter aim to emulate Android components on the JVM and check the configurations of the components. Testing libraries for the UI test in Android include Espresso [1] ad UI Automator [2]. The former is only used inside an application. If there is a need to test components outside an application such as notifications, then the latter should be used instead of the former. In this step, educators have to translate the grading criteria to the testcases and upload the testcases to the starter repository, and then the students' assignments will be tested as specified by testcases.

3.2 Edit `.travis.yml` and `testcases.yml` Files

In order to let Travis build and test automatically and save the results sent from Travis to the database, educators have to edit two files: `.travis.yml` and `testcases.yml`. After preparation of both files has done, educators are able to start the server called `result_collector.py`.

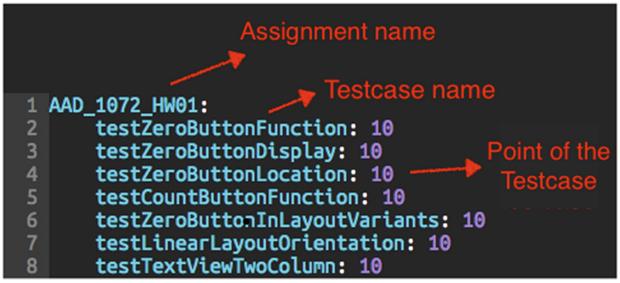

Fig. 3. Example of the testcases.yml

The `.travis.yml` is a configuration file of Travis, which defines the executed instructions to build the project. After a programmer pushes a new commit to GitHub with the `.travis.yml`, the build will be triggered immediately. A job in Travis contains two parts: install and script [18]. The installation of Android SDK is in install part, and an emulator is connected at the part of `before_script`. With respect to the part of `script`, `gradlew` is used to build the Android project. As to the part of `after_script`, we send the result of the building to the server by HTTP POST.

As for the `testcases.yml`, it records the information regarding the testcases of the assignments and is placed under the same directory as the server programs. The `testcases.yml` defines information which is used to create and interact with Sqlite database. Without the knowledge regarding database, educators only need to fill out `testcases.yml` with the assignment names, testcase names and the point of each testcase as shown in Fig. 3, and the server will create the database table that contains results of tests, commit time, branch and commit hash, etc.

3.3 Create Students' Repositories

In this step, educators place the `students.csv` under the directory same as the server programs and utilize CourseManager.py to do a series actions to students' repositories.

```
Timestamp,Student ID,Github Username
2019/3/6 pm 1:04:05,F74042036,[redacted]
2019/3/6 pm 1:04:11,Q56073013,[redacted]
2019/3/6 pm 1:04:51,P76071179,[redacted]
2019/3/6 pm 1:06:44,R76074103,[redacted]
2019/3/6 pm 1:07:35,Q36074502,[redacted]
2019/3/6 pm 1:08:08,P76071284,[redacted]
```

Fig. 4. Example of students' IDs and GitHub accounts

CourseManager.py is a command-line interface tool written in Python. It communicates with GitHub and Travis after authenticated by tokens. Educators can create students' assignment projects, import starter code and add webhook with `start` command, which requires two positional parameters: the name of assignment and starter repository. Considering creating students' assignment projects consumes lots of time, we separate `start` and `invite` commands and execute them independently. By doing so, educators can prepare all assignment projects in advance before class and invite all students as collaborators when announce the assignment.

As shown in Fig. 4, `students.csv` contains students' IDs and their GitHub accounts, which is collected through Google form, in order to create students' repositories and invite the students as the collaborators. When educators create the students' repositories with CourseManager.py, CourseManager.py reads relation between students' IDs and GitHub accounts of the students from the `students.csv`, and then create the students' repositories.

3.4 Update Testcases

If educators want to modify some files in the starter repository, all educators need to do is to push a new commit to the starter repository and execute the `overwrite` command. Similar to `start` command, the `overwrite` command has two positional parameters as well. Modified files including testcases, `.travis.yml`, `README.md` will be synchronized to students' assignment projects.

3.5 Grade

Figure 5 is an example of using the grading tool. After specifying a name and deadline of an assignment, educators can export scores of the assignment via `grade.py` tool, which calculates the scores of the students by reading from the database and accumulating the point of each testcase. Later, `grade.py` will adjust the scores of the students according to the status of the late work and the regulation. Take our Android course for example, if a student's assignment is delayed for **n** weeks, the score of the student will be 0.9^n of the original score. We choose the larger one between the original score and the late score as the final score. If there is a student who modify sensitive files such as testcases and `.travis.yml`, which results in unfair grading, then the date when the student modify sensitive files will be shown in the output.

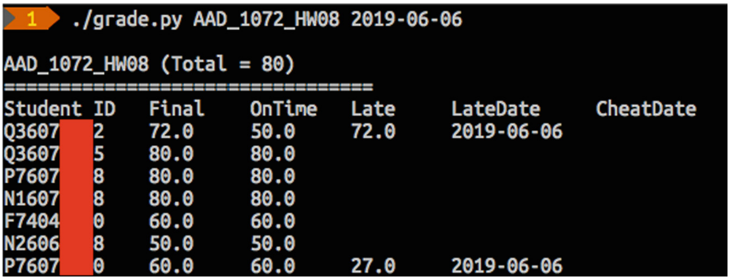

Fig. 5. Example of grading

4 Security Issues

4.1 Encrypt Environment Variables

To prevent attacks from the Internet, sensitive data such as the server's IP or URL, which results of build are sent to, cannot be revealed in `.travis.yml`. The educators can edit the dictionary, `TRAVIS_SECURE_VAR`, in the CourseManager.py, and then the keys and values in `TRAVIS_SECURE_VAR` will be encrypted before added to the `.travis.yml` [17]. In this way, only Travis is able to decrypt and use these secure variables.

4.2 Configurations of the Firewall

To speed up builds in Travis, we run an Android emulator on the server and instruct Travis to connect our emulator before building. While using the remote Android emulator shortens the execution time of a build indeed, the emulator with exposed ports is likely be scanned by a botnet and then compromised. Hence, we execute the commands in Table 1 on the server, which inserts some rules to the iptables of the server and filters out the network traffic from the devices other than Travis to the emulator [14].

Table 1. Commands of iptables

Step	Command
1	sudo iptables -A INPUT -s localhost -p tcp –dport <port> -j ACCEPT
2	sudo iptables -A INPUT -s nat.travisci.net -p tcp –dport <port> -j ACCEPT
3	sudo iptables -A INPUT -p tcp –dport <port> -j DROP

5 Result of Applying Automatic Grading System on Programming Education

Our system was applied in an Android application development course with 140 students enrolled. At the end of the course, we sampled about one third of the students and asked for their opinions on the automatic grading system. The statistical result shows that 72% of the students speak highly of the system. Most of the students tell that an immediate feedback helps them to figure out whether there is any mistake in their programs. Unfortunately, some students reflect the grading logic is not flexible enough, which limit implementation methods of some functions. The extent of limitations depends on how an educator translates grading criteria to testcases. For example, if the goal of an assignment is to create a square, however a student creates a rectangle instead. The student cannot get any point for the testcase just because of the wrong shape. To solve the problem, the educator should claim the goal of assignments clearly before students start doing their assignments. Generally, we think our system is able to improve programming education quality.

6 Conclusion and Future Works

Hands-on programming training is indispensable to cultivate a skillful software developer. However, a system for hands-on programming training is still immature. We aim at designing a system which can help educators manage assignments more easily and provide a better learning experience to students.

In this paper, we develop a set of course management tools based on an existing continuous integration system. Compared with GitHub ClassRoom, our course management tools enable educators to update and synchronize files in the starter repository. Besides, our tools allow educators to place the question and answer branches in the same repository. With our course management tools, educators are able to manage assignments more flexible and stable. A better learning experience can be provided to students as well. Students are able to find errors in their assignments and correct wrong conception immediately. In terms of security issues, we encrypt sensitive environment variables before adding them to the `.travis.yml`. Furthermore, the firewall is set to filter out the malicious network traffic, which prevents our system from being attacked by hackers. After using our system in an Android application development course, 72% of students indicate that the automatic grading system is beneficial to their learning.

In the future, we plan to create a website with Javascript libraries such as D3.js or JQuery for educators. Compared to the CLI, operations on the website are more intuitive for educators. Instead of presenting the information of the students with plain texts, we are going to show the information with charts. For example, the distribution of students' scores can be plotted with a histogram, and the error rate of each testcase can be plotted with a pie chart. In this way, educators are able to track the status of the students faster than before. What's more, after analyzing the status of a student with the data mining technology, we can recommend some additional materials to the student.

After enhancing the user interface and the data analysis, we believe we can build a sounder learning platform for educators to provide a better learning experience to students.

Acknowledgement. This work was supported by the Center for Open Intelligent Connectivity through the Featured Areas Research Center Program within the Framework of the Higher Education Sprout Project by the Ministry of Education in Taiwan. The work of Y.-Z. Cai was sponsored by the R&D enhancement project “R&D of Network Behavior Security Analyses for IoT Devices on Advanced Edge Switch in an AIOT plus SDN Integrated Platform,” which is executed by EstiNet Technologies Inc. and partially sponsored by Hsinchu Science Park Bureau, Ministry of Science and Technology, Taiwan, R.O.C. The work of M.-H. Tsai was supported in part by the MOST under Grant 107-2221-E-006-062 and Grant 108-2221-E-006-112, and in part by the Industrial Technology Research Institute.

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Tasks for Assessing Computational Thinking Skills at Secondary School Level

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Abstract. Computer science has become an essential part of many disciplines. Skills of thinking computationally have become increasingly important for everyone. Systematic development of the skills of computational thinking (CT) includes developing the skills of solving problems by defining the problem, solving the problem algorithmically and analyzing the solution. As there has been a rise of teaching CT skills at secondary school level, an instrument for assessing CT skills is needed. The goal of this study is to modify and empirically test an instrument for assessing CT skills. An instrument with 10 tasks was created and a study was conducted with 649 secondary school students. Confirmatory factor analysis is used to confirm that the instrument is suitable for assessing skills of algorithmic design and pattern recognition. Results show that this modified instrument can be used to assess and set directions for developing CT skills at secondary school level.

Keywords: Computational thinking · Secondary school · Online assessment

1 Introduction

We live in a world where technological progress and computer science have become an important part of many disciplines. In order to be successful in a 21st century society, people need knowledge, skills and competences that facilitate the use of technology. Developing the skills of thinking computationally has evolved from being the way computer scientists think to be a fundamental skill for everyone [1].

Computational thinking (CT) includes various aspects of thinking that should be introduced already at comprehensive school level. While CT has been a popular topic of research for several years now, including research on various age groups, tools and instruments, not much attention has been paid to a systematic approach to teaching and assessment of CT skills at secondary school level. This study uses a previously created instrument for assessing CT skills in middle school [2], developing, testing and using it now in secondary school. An instrument for assessing the CT skills of algorithmic design and pattern recognition at secondary school level is proposed and results are described.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 216–226, 2019.
https://doi.org/10.1007/978-3-030-35343-8_23

2 Theoretical Framework

2.1 Computational Thinking

CT was introduced by Seymour Papert by suggesting the goal of using a computer to solve problems in a way that allows people to better analyze and explain the problems, solutions, and connections between those elements of problem solving [3]. In 2006 Wing [1] started a wave of introducing CT to students by claiming that CT is “the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be carried out by an information-processing agent”. The information-processing agent is described as a computer, a machine, or a human being.

As Wing’s description of CT is rather broad, a more systematic approach to listing the CT skills is needed to help us assess and develop CT skills. This article explores the skills of CT that can be assessed with an instrument used for assessing CT. The next section presents related works on that subject.

2.2 Computational Thinking Skills

Wing [1] suggests a list of skills that should be included in the discussion of CT: problem formulation, abstraction, problem reformulation, decomposition, systematic testing. Those skills indicate that CT is a way of thinking while solving algorithmic problems. The International Society for Technology in Education (ISTE) and the Computer Science Teachers Association (CSTA) have concluded that CT is a problem-solving process that includes (but is not limited to) the following characteristics [4]:

- Formulating problems in a way that enables us to use a computer and other tools to help solve them.
- Logically organizing and analysing data.
- Representing data through abstractions such as models and simulations.
- Automating solutions through algorithmic thinking (a series of ordered steps).
- Identifying, analysing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources.
- Generalizing and transferring this problem-solving process to a wide variety of problems.

A prerequisite for development of CT skills is having an instrument to assess those skills. Several instruments have been used for that purpose. Brennan and Resnick [5] suggest assessing aspects of CT in the context of Scratch projects: project analysis, artefact-based interviews, and design scenarios. Werner et al. introduced instrument called Fairy assessment to manually assess CT skills in Alice projects [6]. These suggestions are oriented towards specific software projects and are difficult to apply to other situations. Selby, Dorling, and Woollard [7] created a matrix for assessing the five skills of CT in a curriculum, but this approach has not been empirically tested in real-life situations and can be time consuming. The tasks from the Bebras informatics competition for assessing the five skills of CT have also been suggested by Dagiene, Sentence and Stupuriene [8]. These tasks include (pseudo)real-life tasks that can be used as starter tasks for a lesson or as a formative part of lesson assessment. Dagiene et al. [8] suggest tasks for assessing the following CT skills: abstraction, decomposition, algorithmic thinking, evaluation, and generalization. Palts et al. [2] used the data from the Bebras informatics competition and found in an empirical study that the tasks load into two factors: *algorithmic design* and *pattern recognition*. Algorithmic design and pattern recognition are two types of tasks that are included in algorithmic problem-solving. As Palts et al. [2] tested the instrument empirically in the middle school environment, several modifications are needed to use it at secondary school level.

Thus, the guiding hypothesis for our study is that the instrument used for assessing CT skills in the middle school can be used, after modifications, for assessing CT skills in the secondary school, and a similar differentiation of two factors of CT can be made.

3 Methodology

This paper presents a modification of the instrument for assessing CT skills in the middle school environment suggested by Palts et al. [2] to make it applicable at secondary school level. That includes developing the instrument that consists of 10 tasks that cover CT skills for solving the problems algorithmically and are characterized through two dimensions – algorithmic design and pattern recognition.

At first, a pilot study was conducted to test the instrument in one school with 35 students from the 11th grade (16–17 years of age). The test included 5 tasks assessing algorithmic design and 5 tasks assessing pattern recognition. The total number of tasks was 10 and performance in each task was rated as correct or incorrect. An online questionnaire was used with a time limit of 40 min, which was considered sufficient to solve the tasks.

As the tasks used in the instrument have been previously used for middle school students, six tasks were changed during the pilot study due to being too simple for secondary school students. Tasks that had over 80% of correct answers were replaced with more difficult tasks from the Bebras competition suggested by Dagiene et al. [8]. The tasks that were added for being suitable in the two-factorial model were Popularity, Word Chains, Irrigation System, Beaver Lunch, Decorating Chocolate, and Building a Chip.

After the pilot, the main study was conducted. The main study included results from 10th grade students from 17 secondary schools. Data was cleaned (798 students started the test, 118 were removed for not finishing the test, and 25 were removed due to duplicates or being unidentifiable). The final study included a total of 655 responses.

Confirmatory Factor Analysis (CFA) was used to confirm that the results from Palts et al. [2] are indicative of the emergence of the two suggested CT skills. CFA for validating the instrument was done by determining the fit indexes Tucker-Lewis (TLI), Comparative Fit (CFI), Root Mean Square Error of Approximation (RMSEA) and Weighted Root Mean Square Residual (WRMR) to confirm that the instrument actually assesses the two CT skills.

As two factors (algorithmic design and pattern recognition) were predicted, a two-factor model was created with five tasks in each factor. The statistical program Mplus (Version 7; [9]) was used for CFA. In order to evaluate the models, we adopted criteria for fit indexes that had been proposed by [10], which are as follows: RMSEA: close fit: $\leq .05$, reasonable fit: .05–.08, poor fit: $\geq .10$; CFI: $\geq .95$; TLI: $\geq .95$.

Variables falling under factor 1 can be characterized as tasks of algorithmic design. Algorithmic design tasks require step-by-step solutions for the (pseudo)real-life problems. The tasks of algorithmic design used in the test are Crane Operating, Popularity, Word Chains, Geocaching, and Irrigation System (see Appendix A tasks from 1 to 5).

Variables falling under factor 2 can be characterized as tasks of pattern recognition. For these tasks, students need to have previous experience with basic algorithms used to solve various problems and recognize those patterns in a task. The tasks of pattern recognition used in the test are Beaver Lunch, Button Game, Decorating Chocolate, Pencils' Alignment, and Building a Chip (see Appendix A tasks from 6 to 10).

These tasks have been suggested for formative assessment in lessons so that teachers can track their students' progress in developing CT skills. This study confirms that these skills can be distinguished in the results based on the two factors.

4 Results

The results describe the CFA findings about the suggested dimensions of CT. The results from ten tasks (true or false) were categorized for assessing two skills of CT: algorithmic design and pattern recognition. Exact descriptions of the tasks used in online test can be found in Appendix A.

Figure 1 shows two factorial model with factor 1 (f1) being algorithmic design and factor 2 (f2) being pattern recognition. The factor loadings of the results from the tasks 1–5 (t1–t5) in factor 1 are from .429 to .745, and factor loadings of the results from the tasks 6–10 (t6–t10) in factor 2 are from .248 to .650. Correlation between the factors f1 and f2 is .677.

The fit indexes of the model were good (TLI = 1.035, CFI = 1.000, RMSEA = .000 and WRMR = .541), which leads us to believe that the empirical study supports the theory of the tasks divided into two dimensions being suitable for assessing the aforementioned CT skills. Although, the individual factor loadings are not very high (.25–.75), together they form two factors with a very high significance.

The tasks can also be suggested for formative assessment in lessons so that teachers can track their students' progress in developing CT skills.

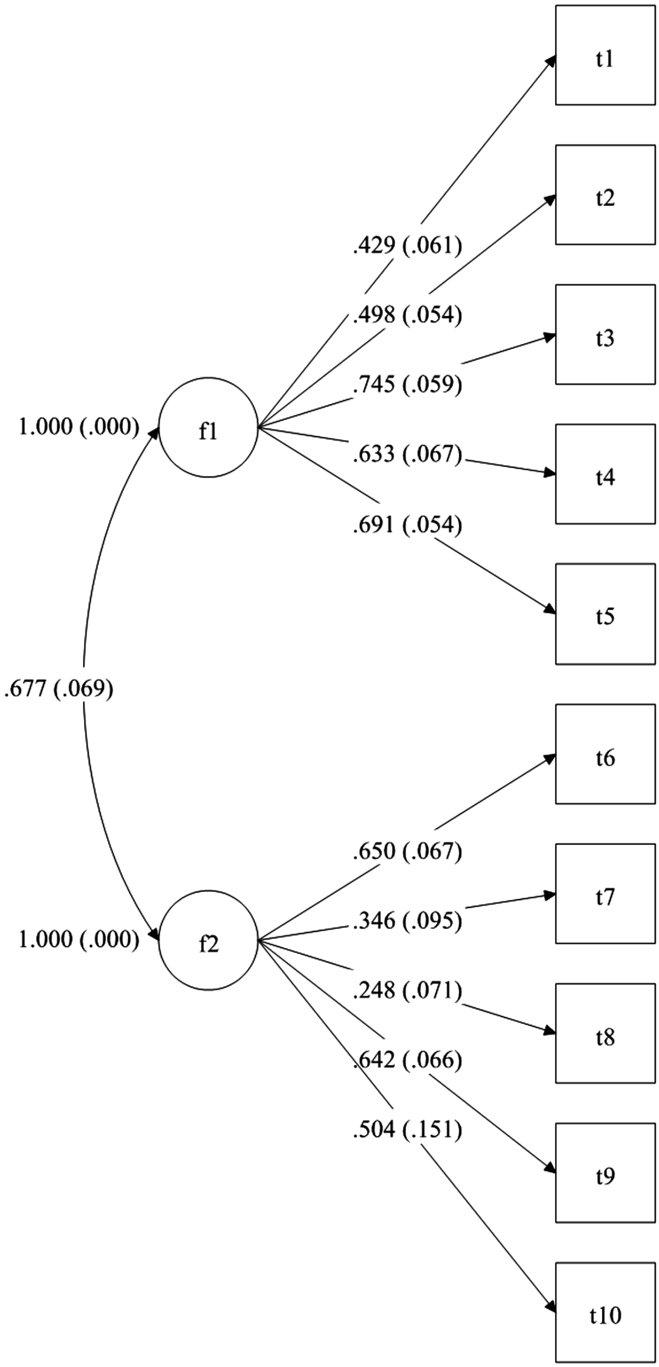


Fig. 1. CFA model with factor loadings of the two factors in the results.

5 Discussion

Assessment of CT skills plays an important role in developing CT at secondary school level. Wing [1] suggests a list of CT skills like problem formulation, abstraction, problem reformulation, decomposition, and systematic testing. Palts et al. [4] have divided those skills into three problem-solving stages: defining the problem, solving the problem and analyzing the solution. Solving the problem has an important role in developing CT by developing CT skills algorithmic design and pattern recognition [2].

This study uses at secondary school level previously composed test for assessing algorithmic design and pattern recognition [2] at middle school level. The results indicate that, after replacing some tasks from the suggested test for assessing CT skills, the test can be used for assessing CT skills at secondary school level.

Compared to other instruments for assessing skills of CT, this test does not need project analysis, interviews or pre-designed scenarios [4]. It is not software specific [6] and does not need manual assessing or matrix for assessing [7]. Also other tasks from Bebras competition [8] can be used for assessing and developing CT skills.

As algorithmic design and pattern recognition are part of the CT dimension of solving a problem, it leads us to the idea of creating lesson activities for integrating the tasks of developing CT skills into the comprehensive school level classroom by using various scenarios in lessons, and then assessing the effectiveness of the activities for development of algorithmic design and pattern recognition. As this instrument does not assess the other two dimensions of CT skills, called defining the problem and analyzing the solution, new tools should be created to assess those CT dimensions. This leads us to raising awareness and knowledge of the CT principles that require further research.

6 Conclusion

It is important to have an educational instrument for assessing the development of CT skills. This study suggests tasks for assessing two CT skills; the tasks can be used in any kind of lessons; they are not limited to specific situation or software; and they can be used effectively in a test. The test consists of 10 tasks with five tasks for each of the two dimensions. The test was first piloted and then used in the main study. The results of the main study show that the 2-factorial model is fitting. The two emerging main factors can be described as algorithmic design (includes mainly tasks of step-by-step solutions) and pattern recognition (includes mainly tasks of recognizing algorithms).

The limitations of the study are that the tasks used in the test are rather small and specific, which means that it may be difficult to create similar tasks. The tasks are only rated as true or false, but they could be developed further by allocating point scores to smaller parts of the tasks. Some tasks were still a little too easy for secondary school students and could be replaced with more difficult tasks. This study does not include scenarios for developing the CT skills that are assessed with the test and, therefore, another systematic approach is required for that purpose.

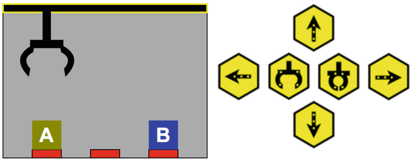
Further research is needed to investigate in more depth the other dimensions of CT skills (defining the problem and analyzing the solution) in order to create tasks for developing and assessing those skills. The relationships between the various skills could be further researched. The tasks are constructed in such a way that they can be used in different subjects tackling computational problems. Another venue of research would be development of activities for integrating the tasks of CT into the secondary school level classroom using various scenarios in lessons and verification of the effectiveness of such activities.

Appendix A

Task 1. Crane operating

The crane in the port of Lodgedam has six different input commands:

`left`
`right`
`up`
`down`
`grab`
`let go`



Box A is in the left position; box B is in the position on the right.

Question:

Using the command buttons, swap the position of the two boxes.

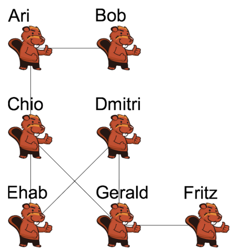
Task 2. Popularity

Seven beavers are in an online social network called Instadam.

Instadam only allows them to see the photos on their own and their friends' pages.

In this diagram, if two beavers are friends they are joined by a line.

After the summer holidays everybody posts a picture of themselves on all of their friends' pages.



Question:

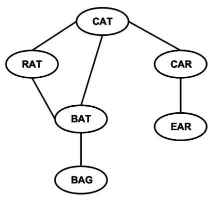
Which beavers' picture will be seen the most?

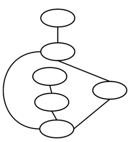
`Ari`, `Bob`, `Chio`, `Dmitri`, `Ehab`, `Fritz` or `Gerald`

Task 3. Word Chains

For his homework, Thomas had to write words on cards and connect them with rubber bands.

The teacher told him to connect any two words that differ by exactly one letter.





Thomas did this, as you can see in the picture on the right.

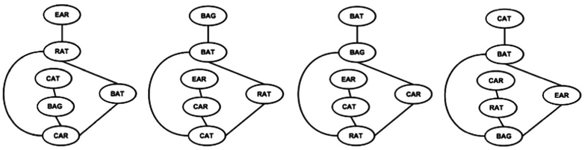
When Thomas returned from having a break he got a surprise.

Peter, his little brother, had erased all the words!

Also, the cards were completely mixed up, as you can see in the image on the left. Importantly, the rubber bands still connected them as before.
Thomas was sure he could put the words back in the correct place.

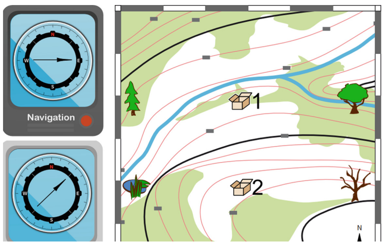
Question:

Which of the pictures below contains the words in exactly the right places?



Task 4. Geocaching

Two friends, Anna and Bob, are searching for treasure.
They have a smartphone app that shows them the direction to the treasure they are looking for.
The two boxes on the map show where the treasure is.
Anna is searching for box 1. Bob is looking for box 2.



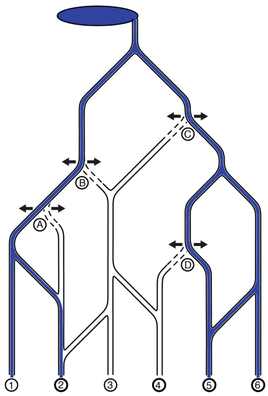
Anna and Bob are standing in the same place. The picture shows the map and a screenshot of the smartphones.

Question:

Where are Anna and Bob standing?

Task 5. Irrigation System

The beavers have created a clever irrigation system for their fields. The water flows from a lake at the top of the hill all the way down to the fields numbered 1 to 6 at the bottom.
Along the water canals, the beavers have installed four water gates A, B, C and D, where the water can only flow either to the left or to the right.
Answer and Explanation:



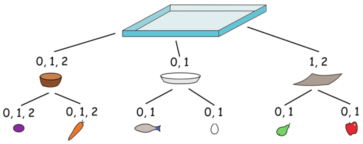
Question:

Which water gates should be changed, so that only the fields numbered 2, 4, 5 und 6 are irrigated?

Task 6. Beaver Lunch

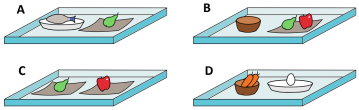
Hm, what to take for lunch today?
The cafeteria gives instructions on how to choose a Beaver lunch.

This is shown as a diagram:



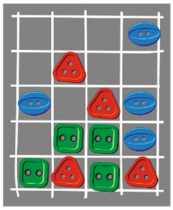
Below the tray you see different types of food containers.
The numbers indicate how many containers of this type can be added to a tray.

Each container can only have food items put in it that are shown below it.
The numbers indicate how many food items of this type can be added to the containers.
Question:
Which of the following lunches is not a proper Beaver lunch?



Task 7. Button Game

You can play this game on the ground. Draw a board and put the colored buttons. One step means to move one button to top, down, right or left through one box.

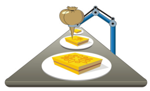


Question

What is the least number of steps to put all green squared buttons into one line at the bottom of the board?

Task 8. Decorating Chocolate

Everything is automated in a chocolate factory: the sweets are sliding on a conveyer, and there is a robot with a syringe, which draws different shapes.

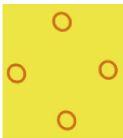


The robot can perform these commands:

1. Leaf – draws: 
2. Circle – draws : 
3. Rotate k – rotates the sweet clockwise by k°.
4. Repeat n

[…
] – repeats the commands inside brackets n times

For example, to perform
Repeat 4
[Circle
Rotate 90]

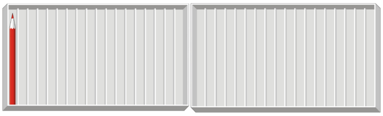


The robot will draw the flower as following:
Question
Which of the following command sequences the robot does NOT draw the flower?

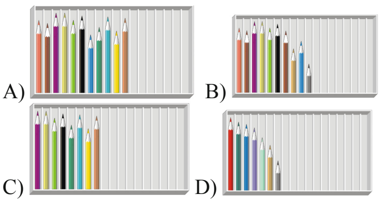
A. Repeat 6 [Rotate 30 Circle Rotate 30 Leaf]	B. Repeat 6 [Leaf Rotate 60] Rotate 330 Repeat 6 [Circle Rotate 300]	C. Repeat 6 [Leaf Rotate 60] Repeat 6 [Circle Rotate 60]	D. Repeat 3 [Rotate 120 Repeat 2 [Leaf Rotate 30 Circle Rotate 150]]

Task 9. Pencils' Alignment
A little beaver is bored of drawing and wants to play with a box of pencils.

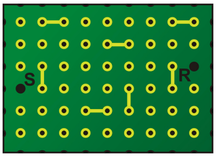
- Pencils are taken from the box one by one from left to right.
- Pencils are placed in Mom's and Dad's boxes, also from left to right.
- The first pencil is placed in Mom's box.
- Each other pencil is compared with the last pencil placed in Mom's box. If it is not longer than the last pencil placed in Mom's box, then it is also placed in Mom's box. Otherwise, it is placed to Dad's box.



Mom's box after first pencil is placed, Dad's box after first pencil is placed
Question
What will Dad's box look like after the little beaver places the last pencil?



Task 10. Building a Chip



A small chip is composed of a grid of contacts (marked as dots). Some are already connected (marked as line segments). Connectors are always only between adjacent contacts, horizontally or vertically. We want to connect S and R with a continuous sequence of connectors, which do not touch any already connected contacts.

Question?
How many different ways are there to connect S and R with the least possible number of connectors?

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The Effects of Interactive Learning Environment to Enhance the Algorithmic Thinking for Data Structure

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Abstract. This study was aimed to (1) to compare the achievement of control group using the interactive learning environment and the regular class, (2) to compare the Algorithmic Thinking of control group using the interactive learning environment and the regular class, (3) to study relationships between Algorithmic Thinking and learner's achievement of control group and the regular class and (4) study learner's attitudes learning with interactive learning environment to enhance creative thinking in problem solving. The developmental research (phase III) was employed in this study. The procedures were as following: (1) design process (2) development process (3) evaluation process. The target group is 24 of Bachelor's degree students in Computer Education, faculty of Education, Khon Kaen University. The result revealed that: (1) The learning achievement of the experimental group was statistically significantly higher than the controlled group at .05; (2) The Algorithmic Thinking of the experimental group was statistically significantly higher than the controlled group at .05; (3) The learning achievement was significantly and positively related to Algorithmic Thinking at the .05 level; and (4) The learners' attitude of learners towards learning with the interactive learning environment was at the highest level ($\overline{X} = 4.52$, $S.D. = 0.54$).

Keywords: Interactive learning environment · Algorithmic Thinking · Data structure

1 Introduction

The present world society has continuously changed in many aspects as a result of industrial revolution, technology, and the surrounding. This makes the world situations different from the past century. We are entering the world of the 21st Century which progresses speedily owing to the use of information technology that connects information from all regions of the world together, with a lot of impact on our living. Development of learners in the 21st Century is therefore different from the past centuries due to tremendous changes, especially the system of education that now needs to be reformed. The new contexts of the world have to be taken into account to be in line with the arrival of new situations [1]. The world of education has also changed dramatically during the recent past. Education accepted as construction of knowledge, competency, and development of a person's potentiality is where the learners are

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 227–234, 2019.
https://doi.org/10.1007/978-3-030-35343-8_24

centered. This means all learners are given a chance to perceive and increase their knowledge and experience, and at the same time their potentiality is as much as possible sharpened with no limits, covering the intellects, ability to perceive and more. Learners are expected to learn without constraints in time and place. The other important point is provision of opportunities for learners to think for problem solving, analyze and synthesize knowledge at all levels [2]. Therefore, thinking skills should be enhanced for learners of the 21st Century who will be confronted with multiple complex problem bases and the leaping technological growth. Finally, the target of education at present requires learners to be able to creatively solve problems surrounding themselves with efficient use of technology.

The thinking that covers the necessary process and skills for the 21st Century is the creative problem-solving thinking. The thinking processes that enable the design and development of various new concepts consist of 'Convergent Thinking', which relies on former knowledge and experiences and 'Divergent Thinking', which refers to creative thinking including fluent thinking, initiative thinking, flexible thinking, and elaborate thinking, all of which mutually and appropriately supporting one another before being creatively modified for problem solving [3]. It can be seen that the process of complex problem solving requires advanced thinking, i.e., both convergent thinking and divergent thinking should be applied harmoniously in order to lead to success. Before learners can solve any problem, they would use convergent thinking to construct various concepts. This thinking spreads out aspects; it is free thinking beyond any rules and without logics or principles but would lead to the best answer. They can use divergent thinking, which means analyzing based on logics and principles in order to acquire the best answer. The study by Guilford concludes that there are two major thinking behaviors. One is convergent thinking which is one-way thinking and is a narrow problem solving process. There are few alternatives that lead to the best way to solve the problem which is selected from the environment surrounding that problem. It is referred to as critical thinking which requires a wide range of reasoning. The other major thinking behavior is divergent thinking, which is the brain process enabling thinking in various aspects and various directions in order to find unlimited numbers of answers, leading to new and uncommon idea from the set stimulant. Thinking can be in various directions and relies on imagination, intuition, intention, and is referred to as creative thinking. Thus, for problem solving in the 21st Century, creative thinking and critical thinking are very important. The two thinking processes must harmoniously interrelate, and problem solving will be successful or not depends on the use of these two skills, not only one of the two [4].

From the above reasons, the researcher designed and developed the interactive learning environment to enhance creative problem-solving thinking for computer education students. The results of the study on the efficiency of the learning environment model developed in Phase 2 indicated that the learning environment model is efficient. Hence, the researchers used the learning environment model in the study of the creative problem solving thinking of the learners.

2 Research Objectives

1. To compare the achievement of control group using the interactive learning environment and the regular class.
2. To compare the Algorithmic Thinking of control group using the interactive learning environment and the regular class.
3. To study relationships between Algorithmic Thinking and learner's achievement of control group and the regular class.
4. Study learner's attitudes learning with interactive learning environment to enhance creative thinking in problem solving.

3 Research Scopes

This study was conducted based on the Developmental Research Type I [5], which focused on the process of evaluation of the interactive learning environment. The details of this process are as follows:

3.1 Target Groups

The target groups under evaluation process is Twenty first year undergraduate computer education students, Faculty of Education, Khon Kaen University who registered for the 2nd group of the course ED252004 INTRODUCTION TO ALGORITHMS AND DATA STRUCTURE during the first semester of academic year 2018.

3.2 Research Design

The Posttest Control Group Design was used to study the learning achievement and Algorithmic Thinking and correlation studies to study the relationship of two variables in order to determine whether those variables are mutable or vary in contrast.

3.3 Research Tools

1. Experimental tool was the interactive learning environment passing the effectiveness criteria in design and development process of the research.
2. Data collecting tools consisted of:

   – The test of Algorithmic Thinking which was developed according to the framework of Nili [6]. The test comprised 5 main components: (1) analyze problem, (2) find idea, (3) formulate algorithm, (4) play algorithm, and (5) reflect algorithm.
   – The achievement test was a subjective test with scoring guideline for each test item by setting rubric for holistic scoring.

– A survey form for learners' attitudes towards the interactive learning environment. This consisted of open-ended questions including 3 aspects, namely, the content, the web-based learning, and the design that enhanced Algorithmic Thinking. Space was given for respondents to add reasons, additional opinions and other suggestions.

3.4 Data Collection - This Included

1. The interactive learning environment was used in instruction, following these procedures:
   - Explaining the students on the methods of learning with the interactive learning environment.
   - Introducing to the lesson by linking the students' schema with the content to learn, i.e., Sorting and Searching.
   - Dividing the students into 2 groups.
   - The students learning with the interactive learning environment on Sorting and Searching – by having them study the problem base and find a means to obtain the answer from the different components of interactive learning environment the such as the resource center and the coaching center in order to find the answer. While they were learning, learners cooperated to find the answer and discussed together to draw conclusion. The researcher coached and encouraged learners to think for the solution and assisted those who needed help. The instruction using the interactive learning environment was performed 3 h each for a total of 4 times.
   - The researcher and the students made a conclusion of the lesson at the end of each period.
2. After learning with the interactive learning environment, the students did the achievement test, the test of Algorithmic Thinking and the survey of attitudes after learning.

4 Data Analyses

Data analyses were performed both quantitatively and qualitatively:

1. Learners' Algorithmic Thinking from the test was analyzed using descriptive statistics including percentages, means, and standard deviations.
2. Learners' learning achievements from the achievement test were also analyzed using descriptive statistics including percentages, means, and standard deviations.
3. The study of the relationship of thinking process and learning achievement of learners learning the interactive learning environment and group of students who learn with normal teaching. Use the results of thinking measurement, algorithm and learning achievement of both groups by the Spearman Rank Correlation Coefficient and Pearson Correlation Coefficient.
4. The attitudes of learners on the interactive model collected from the open-ended survey questions were concluded and interpreted.

5 Results

The results of the study are as follows:

1. The results of the comparison of learning achievement by using the t-test found that learning achievement in both groups gave significant differences, the learning achievement of the experimental group was higher than the control group with statistical significance at .05.
2. The results of the comparison analysis of Algorithmic Thinking by using the t-test, it was found that the thinking of both groups gave significant differences. The Algorithmic Thinking of the experimental group was higher than the control group with statistical significance at .05.
3. The results of the relationship analysis revealed that the learning achievement of learners learning through the interactive learning environment there is a very high level of relationship with the Algorithmic Thinking (r = 0.88) with statistical significance at .01 level and the learning achievement of learners who study normal style is related to the Algorithmic Thinking in Very low level (r = 0.24) with statistical significance at .05 level (Table 1).

Table 1. The results of the relationship analysis of learning achievement towards Algorithmic Thinking of the experimental group and the control group analyzing with Pearson Correlation.

Group		Correlation
Experimental	Pearson Correlation	0.88^{**}
	Sig. (2-tailed)	0.00
Control	Pearson Correlation	0.24
	Sig. (2-tailed)	0.44^{*}

*Sig .05, **Sig .01.

- The attitudes of the 12 learners towards the interactive learning environment were surveyed using the survey form on 3 aspects: the learning content, the web-based media, and the interactive learning environment. The results were analyzed based on the basic statistics including the means $(\overline{X})$ and the standard deviations (*S.D.*). It was found that the students agreed with the content and the learning environment at the highest levels ($\overline{X} = 4.50$, *S.D.* = 0.45 and $\overline{X} = 4.47$, *S.D.* = 0.52, respectively) (Figs. 1 and 2).

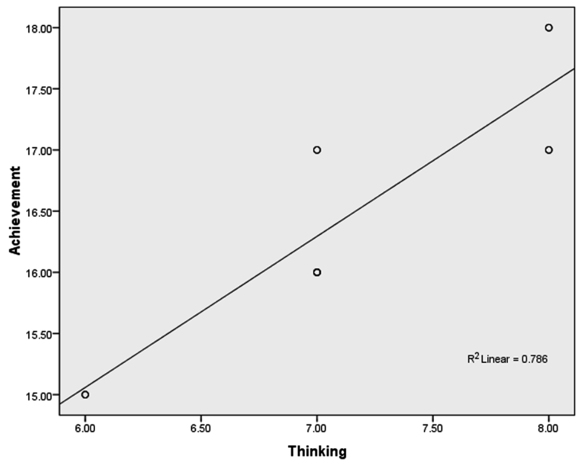

Fig. 1. Showing the results of the relationship analysis of learning achievement towards the Algorithm Thinking of the experimental group.

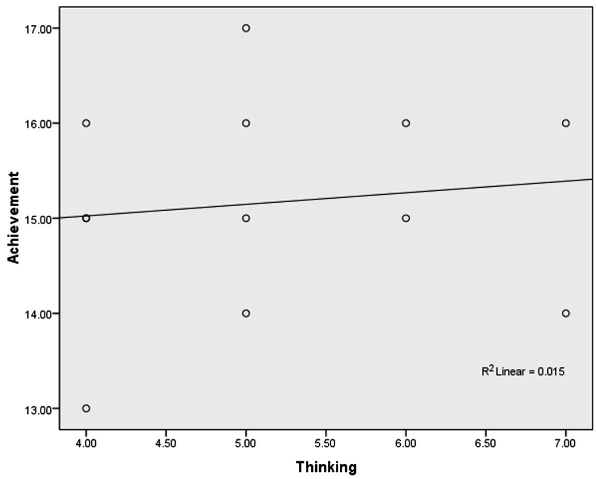

Fig. 2. Showing the results of the relationship analysis of learning achievement towards the Algorithm Thinking of the control group.

6 Discussion

1. Learning achievement in both groups showed significant differences. The learning achievement of the experimental group was higher than the control group with statistical significance at .05 level. Which is consistent with Prawit [7] that have studied the learning achievement of learners after studying with the learning environment according to the constructivist theory and found that the learning achievement of the experimental group was significantly higher than the control

group. Because of learning on the interactive learning environment is a self-learning and group process with a coach who is just a coach that facilitates and gives advice away, allowing learners the freedom to learn without pressure and the interactive learning environment is a system that designed and developed on an interactive system that can present information solutions immediate and during the problem solving, students can immediately adjust their understanding, students are able to immediately know if the design concept is correct or not and can be adjusted immediately.

2. Learning achievement of learners who learn with interactive learning environment is a very high level of relationship with the Algorithmic Thinking ($r = 0.88$) with statistical significance at .01 level and the learning achievement of learners who study normal style is related to the Algorithm Thinking in very low level ($r = 0.24$) with statistical significance at .05 level, which corresponds to Juraj [8] that has developed Computer Science courses and the research shows that we can develop thinking steps in the programming classroom and result in learning achievement of learners much better. We can develop the curriculum by embodies the Algorithmic Thinking thought the process, the algorithm directly affecting the learning of computer science because this idea is the core of learning. It is very important in computer science teaching. Especially for programming that require an effective algorithm design before developing the program further.

7 Recommendations for Further Research

1. A study should be conducted on the design of each component to see how it supports the learners' Algorithm Thinking process, for example, problem base and design of scaffolding, in order to apply in designing interactive learning innovations that enhance learners' Algorithm Thinking.
2. A study should be conducted on learners' Algorithm Thinking process before learning with the interactive learning environment in order to analyze each learner's potentiality.
3. A comparative study can be performed on the Algorithm Thinking process between the control group and the experiment group in order to distinguish clearly between the two groups.

Acknowledgements. This research project is supported by National Research Council of Thailand.

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Design and Evaluation of an Interactive Teaching Platform for Guided Instruction in Programming with Real-Time Compilation

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Abstract. The current information age puts a high premium on programming skills, with education systems around the world rushing to integrate programming instruction into national curricula as early as elementary school. Programming instruction is complicated, however, by inconsistencies in course content and mismatches between instruction goals and the learner's current ability level, which can lead to learner frustration and poor learning outcomes. Lack of appropriate practice methods also negatively impacts learner performance and knowledge acquisition. This study describes the design of an interactive guided instruction platform for real-time program compiling based on JavaScript. The program learning unit uses text designed with incremental and progressive levels of difficulty, along with a programming assistance learning platform. It provides step-by-step online interactive training using an editing interface that visualizes and compares the execution results of the program, allowing learners to repeatedly practice each task using different approaches and parameters, thus helping learners develop autonomy, critical thinking and self-confidence, thus improving learning motivation and learning outcomes. The course automatically records learner progress, allowing learners to monitor their performance against past performance and current benchmarks, and to plan for future learning. The system detects learning difficulties and bottlenecks, providing appropriate learning assistance as needed, along with support mechanisms including discussion forums and other functions, allowing learners to pose questions and interact with instructors and other learners in a modular mutually assisting community.

Keywords: Learning effectiveness · Interactive design · Programming · Teaching platform

1 Introduction

We live in a post-industrial Information Age in which software programming is shifting from a highly specialized skill to one which is needed by a much wider range of professionals. Nations have responded by instituting programming as a mandatory

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 235–240, 2019.
https://doi.org/10.1007/978-3-030-35343-8_25

course requirement at increasingly younger ages, often placing it alongside foreign languages in terms of importance.

However, current approaches and materials for programming instruction are plagued by inconsistency, increasing learner frustration and reducing learning outcomes. Over time, this can contribute to a failure of self-confidence, sapping motivation. These problems are exacerbated by unfriendly user interfaces and debug modes, and a failure to accommodate differences in learning style and preference, and unsophisticated approaches to mapping materials to current ability levels [1]. Increasing learner autonomy and motivation requires the development of skill level-appropriate learning content, systematic guided learning, and appropriate learning aids [2].

This study describes the development of a step-by-step guided interactive learning program with a real-time code compiler that allows learners to practice and repeat learning tasks with the system recording performance and progress automatically in the background, allowing learners to master the individual learning stages, supplemented with discussion forums and personal blogs to help users collaboratively overcome learning challenges [3]. The platform is fronted by a visual interface designed to maximize learner convenience and confidence.

The platform is implemented for instruction in JavaScript programming, with evaluation of impact on learning outcome and learner motivation, with the following objectives:

1.1 Reduce Barriers to Entry and Improve Learning Outcomes

A step-by-step interactive learning method is designed to allow learners to gradually understand program concepts and logic, and to reduce barriers to program learning, thus improving learning outcomes.

1.2 Interactive Real-Time Program Compilation, Practical Operation Drills

The interactive program editor features real-time visualizations of compilation results, allowing the learner to review code execution results during the exercise, thus enhancing learner understanding of the meaning of various code components during the task process, encouraging experimentation and reducing fear of failure.

2 Literature Review

2.1 Interactive Interface Technology

To optimize UI information content, this research uses the interface design uses HTML5, CSS3 and JavaScript to maximize UI information content. In current front-end devices, HTML5 has achieved a high degree of compatibility, using CSS3 for Dynamic Visual Information Displays, 2D/3D transition effects, media queries and other functions, thus the page can provide special effects without plug-ins. CSS3 ensures the compatibility of different device widths while allowing for Design

Responsive Web (RWD) functionality. The present study uses these techniques to product a step-by-step design for interactive guidance functions that not only achieve cross-device conversion and display, but also use JavaScript to improve human-computer interaction and user friendliness to produce a better overall user experience.

For visual presentation, this study uses Code Mirror's Code Editor which accommodates multiple language modes and plug-ins, provides more advanced editing functions, is compatible with most current browsers (IE8/9/10/11, Chrome, Firefox, Safari, etc.), is mobile device compatible, and supports over 100 languages, including C/C++, C#, Java, PHP, JavaScript, and Python, along with SQL, wiki, Markdown and other file formats. The editor's powerful and versatile language mode system enhances its interactivity. Therefore, this study uses this editor to construct an interactive program compiler for the teaching platform, allowing learners to design courses in online learning.

2.2 Programming Learning

Programming is an important basic skill in the information technology industry. Chen (2007) noted that the key to effective programming instruction is to familiarize learners with the logical concepts of programming, and to help them use the associated techniques to solve problems [4]. However, few current programming textbooks are suitable for use by beginners who thus struggle to understand the underlying concepts, resulting in poor learning outcomes. In addition, during the compiling process, novices are unfamiliar with the error codes, making it difficult for them to identify or understand the underlying problem [5].

Therefore, this research focuses on developing effective instructional design for novice programmers, constructing an interactive guided real-time compiler instruction platform, enhancing novice understanding of programming concepts through interactive guided design and real-time code compilation and result rendering. The platform concept incorporates discussion forums and personal blogs to help beginners quickly and easily share and access information that will help them solve problems, while improving the learners' sense of achievement, thus enhancing learning motivation [6].

3 Research Methods and Procedures

Based on the research background and motivation, this study seeks to improve learning outcomes for novice programmers by designing a step-by-step learning unit, combined with interactive guidance and a real-time compiler instruction platform, integrating the overall learning process with unit assessments to ensure learners master the required skills and concepts and automatically tracking learning performance to provide the instructor with alerts reflecting learning bottlenecks for individual students [7].

3.1 System Description

The proposed interactive platform and instant compiler instruction platform is built using webpage technology. Based on a Client-Server model, the system is divided into a web client and server.

Web Client

The web client is based on the HTTP protocol, while the user interface is designed using CSS3, JavaScript and HTML5. CSS3 is mainly implemented using Bootstrap 4 to achieve responsive web design (RWD). Code Mirror is used as the program editor. JavaScript uses JSON as a data object to ensure the consistency of basic formats. Web content is a reciprocal conceptual framework, using Web HTML to link data objects with JQuery and AngularJS.

Server Technology

The web server runs Windows Server to establish an Internet information service environment. Node.js Express is used to construct a web API as a bridge to allow for serial data reading and analysis, with results and related information stored in a MongoDB database.

3.2 System Architecture

The system architecture is divided into three parts: Interface, System and Database. Figure 1 shows a structural diagram of the system.

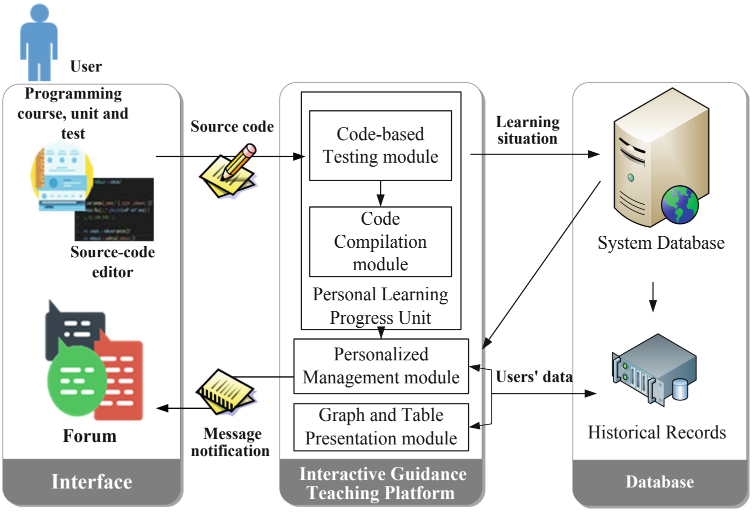

Fig. 1. System architecture.

Interface
The interface is divided into two parts. The first part encompasses the course content and code editor, which provide the explicit instructional guidance and practice environment, providing users with a controlled setting in which to compile their code and immediately compare the results against expectations. The second part includes forums and blogs, allowing users to pose questions to other learners and access supplementary information provided by the learning community, thus making it faster and easier for learners to find the correct solution.

System
The System consists of four parts: individual learning progress, verification code, compiled code, and data management. The progress module tracks individual user performance, allowing the user to customize her learning plan according to her own pace. The user inputs the verification code during a practice session. If the input code is incorrect, the system will display a message prompt advising the learner of the problem and requiring revision, thus helping the user learn to avoid conceptual errors. Once the input code is correctly inputted, the compiler presents the compiled code results to the user. The data management module manages the personal information of each user, along with the content of the online discussion forums and blogs and the participation of each user therein, and processes search queries.

Database
The database stores the user's personal data and learning history, allowing learners to pick up from where they left off, review their previous session, and move forward without interruption. Forum and supplementary information content are stored on and served from the cloud, allowing learners to learn collaboratively.

4 Conclusion

Based on the above description, this study makes the following contributions:

4.1 Use Interactive Guidance to Enhance Learning Motivation and Confidence

This system provides learners with an interactive platform that provides step-by-step supported instruction in programming, helping learners develop an intrinsic interest the subject, thus stimulating learner motivation, enhancing problem solving skills, and increasing learner self-confidence.

4.2 Step-by-Step Learning Enhances Learning Outcomes

The system provides novice programmers with step-by-step, detailed and accessible instruction, accompanied by comprehensive and fully supported practice modules that ensure learners have mastered each concept before moving on to the next topic, thus improving learning outcomes.

Acknowledgment. The authors thank the support of Ministry of Science and Technology of the Republic of China to this work under Grant No. MOST 108-2511-H-005-001-MY3, MOST 105-2511-S-005-001-MY3 and MOST 107-2813-C-025-034-H.

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Design and Framework of Learning Systems

Designing Framework of Constructivist Digital Learning Environment Model to Enhance Creative Thinking for Undergraduate Students

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Abstract. Creative thinking is the ability to generate new ideas in various ways due to the adaptability of existing thinking as well as the performance of problem solving. This can foster student's creative thinking. This study was aimed to synthesize the designing framework of constructivist digital learning environment model to enhance creative thinking for undergraduate students. Research target groups were (1) 90 undergraduate students registered in the faculty of Education and (2) 3 experts for this designing framework. Model Research phase 1 Model Development was employed. Qualitative data was collected by Document Analysis and Survey method, and the data was then analyzed by interpreting and concluding. Research results revealed that the designing framework comprised 5 stages as (1) Activating cognitive structure and creative thinking (2) Supporting cognitive equilibrium (3) Enhancing cognitive structure accommodation (4) Enhancing creative thinking and (5) Supporting and fostering knowledge construction. Besides, the model components consisted of 7 parts as (1) Problem based (2) Learning resources (3) Collaboration center (4) Cognitive tools center (5) Creative thinking center (6) Scaffolding center (7) Coaching center. The evaluation results were hence shown that the designing framework had theoretical validity and consistent with claimed theories.

Keywords: Digital learning environment · Constructivist · Creative thinking

1 Introduction

Moving into the 21st century, it influences the changes of the economy and society systems, especially in education system. Based on the report of Skill Shift: Automation and the future of the workforce, [1] it claims that there is a transformation of worker skills in 2030. Creative thinking is highlighted since the turning up of new technology, products, and working styles, so that human resources is required to this shift.

With regard to the 12th National Economic Development Plan, it claims that the limitations of Thai education in terms of curriculum and learning style that emphasize

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 243–251, 2019.
https://doi.org/10.1007/978-3-030-35343-8_26

only learn by rot. This endorses the lack of self-knowledge construction neither creative thinking as well as the use of information technology that should lead to lifelong learning. This means that Thailand should be aware of the development and learning that promotes creative thinking.

Hence, it is necessary to change teaching paradigm. Encouraging of self-knowledge construction by using a design of learning that based on theories of fostering learners to discover, construct knowledge, and promote creative thinking. As that so, the theories applied to enhance creative thinking comprised Constructivism theory that aims to construct knowledge and Guilford's creative thinking theory [2] with 4 components as fluency, flexibility, originality, and elaboration which must consistent with the design and development of constructivism learning environment. The environment is also designed with the principles of media attributes and media symbol system as hyperlink, hypertext, hypermedia, as well as picture and sound. Learners then are able to design and develop new things originally, find new ideas, and adapt or replace existing ones.

All mentioned above, the importance of the synthesizing of designing framework of constructivist digital learning environment model to enhance creative thinking for undergraduate students is emphasized to assure the quality of the design of the constructivist digital learning environment model. This synthesizing of designing framework is significant to the constructivist digital learning environment model to enhance creative thinking for undergraduate students as a guideline that based on theoretical framework and research methodology.

2 Research Purpose

This study was aimed to synthesize the designing framework of constructivist digital learning environment model to enhance creative thinking for undergraduate students.

3 Research Methodology

Employed by Model research, phase 1 Model Development [3] via Document Analysis and Survey Research.

3.1 Target Group

Target group in this research consisted of 3 experts for the evaluation of the designing framework and 90 undergraduate students which 30 each from faculty of education of Rajabhat Nakornratchasima university, Rajabhat Roi-et university, and Rajabhat Loei university.

3.2 Research Instruments

- Recording form for synthesize the designing framework of constructivist digital learning environment model to enhance creative thinking for undergraduate students.

- Evaluation form for the experts used in designing framework of constructivist digital learning environment model to enhance creative thinking for undergraduate students' evaluation.

3.3 Data Collection and Data Analysis

The data was collected to be used in framework synthesizing as the following: (1) The framework of the designing framework of constructivist digital learning environment model to enhance creative thinking for undergraduate students was synthesized by methods of data interpreting and descriptive analysis. (2) The designing framework based on the theatrical framework was analyzed by data interpreting and using of descriptive analysis on the framework synthesis recording form. (3) Model components were proposed to advisor and experts to examine the consistency between theories and the designing framework by using the evaluation forms through data interpreting and descriptive analysis. Its results and recommendations were then applied to improve the model.

4 Research Results

The results of the synthesizing of designing framework of constructivist digital learning environment model to enhance creative thinking for undergraduate students were found that there were 5 stages of creative thinking enhancement as (1) Activating cognitive structure (2) Supporting cognitive equilibrium (3) Enhancing cognitive structure accommodation (4) Enhancing creative thinking and (5) Supporting and fostering knowledge construction. Also, 7 components of the model as (1) Problem based (2) Learning resources (3) Collaboration center (4) Cognitive tools center (5) Creative thinking center (6) Scaffolding and (7) Coaching center.

- Activating cognitive structure and enhancing creative thinking. In this first stage, it was designed based on the theory of Cognitive Constructivism by Piaget. [4] It believes that a student who is provoked with problems that lead to the condition of cognitive conflict, he or she must try to adjust their cognitive construct equilibrium by assimilation or accommodation methods. As well, principle of Enabling Context based on OLE [5] that Externally Induced or authentic learning task must have to enhance their creative thinking along with 4 procedures of creative thinking theory of Guilford, 1967 as Fluency, Flexibility, Originality, and Elaboration. All mentioned, this was to design the model component as **Problem Base** (see Fig. 1).
- Supporting cognitive equilibrium. Information processing theory by Klausmeier [6] which helps the students to have sensory register and memorize in short-term and long-term memory. The information was intensively designed for student's attention in forms as text design as italic or bold font, underlined or highlighted words. As well, for connecting between the prior and new knowledge in order to be stored in long-term memory. Cognitive load theory by Sweller [7] focuses on the design to reduce eternal cognitive load due to the limitation of working memory that only process information in the number of 7 ± 2 in only 15–30 s. So, chunking method

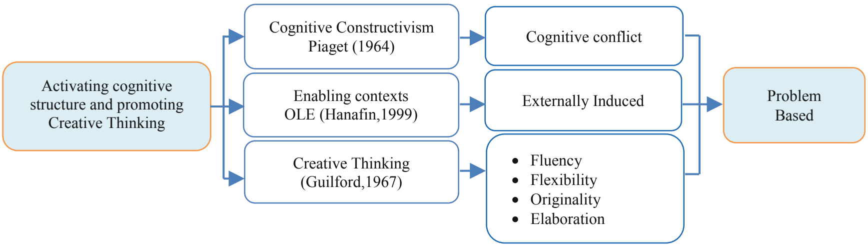

Fig. 1. Theoretical framework designing problem base.

was used to group categorizes of related information in hierarchical network and presented through media symbol system as picture, animation, text, and sound. Schema theory were basically used to design as conceptual thinking pictures which presented it relationship or Schema as context. Moreover, SOI model principle of Mayer [8] that helps the students to select, organize, and integrate information, was part of this process to design its component **Learning Resources** (see Fig. 2).

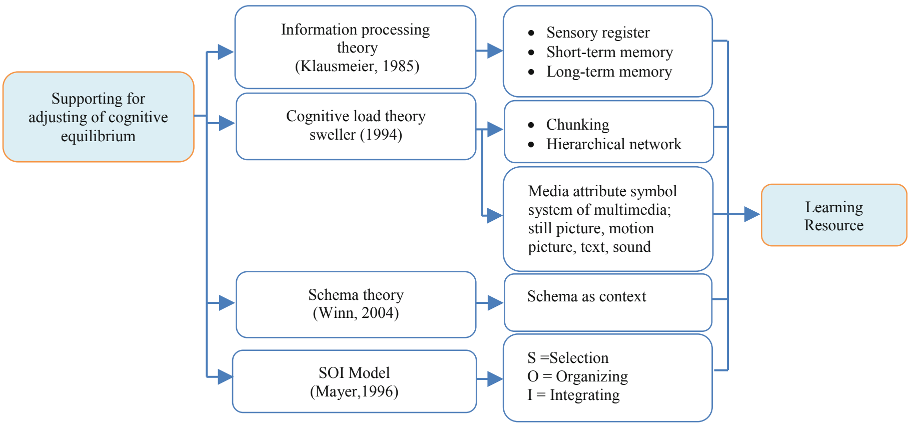

Fig. 2. Theoretical framework designing Learning Resources.

- Enhancing cognitive structure accommodation. Theory of Social Constructivism that fosters students to work collaboratively via sharing their ideas and experiences also adjust their misconception and improve cognition. They can collaboratively communicate to gain multiple perspectives with teachers, friends, and experts inside and outside classroom via Facebook, Line, and Email. All mentioned, **Collaboration Center** was then designed. Whereas, principle of OLEs [5] that owns the principle of cognitive learning tools as (1) Seeking tool-support student's searching and discovering by search engines as Google (2) Collecting tool-help them collecting related information in Documents Online (3) Organizing tool-assist them to build up the relationship among Ideas by mind map and (4) Communicating tool-foster them to communicate and discuss within their groups and with teachers and experts via Facebook, Line, and email. This component was called **Cognitive Tool Center** (see Fig. 3).

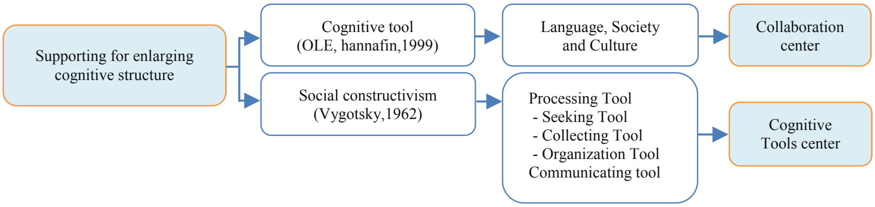

Fig. 3. Theoretical framework designing Collaboration Center and Cognitive Tool.

- Enhancing Creative thinking. The component was designed based on the theory of Creative thinking of Guilford [2]. Its 4 aspects as (1) Fluency means the ability of producing outcome as most as ones can in limited time (2) Flexibility means the ability to construct something flexibly and can be used in various way differently (3) Originality is defined to the ability to originate something with the focus of its characteristics and situations (4) Elaboration is the ability to measure, implement, think in details, and focus on its usage obviously. This was the design of **Creative Thinking Center** (see Fig. 4).

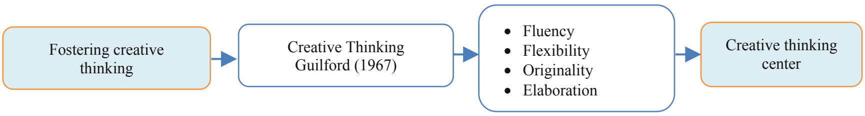

Fig. 4. Theoretical framework designing Creative Thinking center.

- Supporting and fostering knowledge construction. Social constructivism theory claims that a student who is in the lower of zone of proximal development, he needs to have the assisting for learning. As well, principle of Open Learning Environments (OLEs) of Hannafin et al. [5] as 4 Scaffoldings as (1) Conceptual Scaffolding-help students to create their conceptual thinking towards their problem bases and understand them easily (2) Metacognitive Scaffolding-assist them to reflect their thoughts and self-regulation, and guide them for a solution while learning (3) Procedural Scaffolding-convenient them with the instructions of tools, materials, centers (4) Strategic Scaffolding is designed to propose learning strategies for them. **Scaffolding Center** was then designed. Besides, Cognitive Apprenticeship of Wilson and Cole [9] which emphasizes on being active-learner based on guidelines of experts. They can recommend, guide, and provide solutions for the students to adjust their misunderstanding. This component was called **Coaching Center** (see Fig. 5).

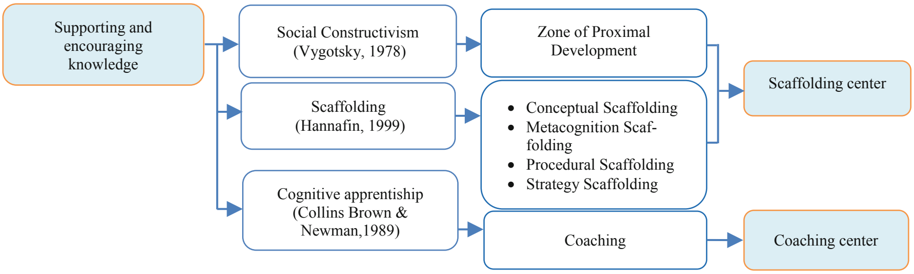

Fig. 5. Theoretical framework designing Scaffolding Center and Creative Thinking center.

The evaluation of the experts towards the designing framework was found the validation of consistency on every theory which comprised (1) context based (2) learning psychology based (3) pedagogical based (4) media and technology based (5) creative thinking based and (6) neuroscience based. Those bases hence were used to design the model component as there are 7 components as (1) Problem based (2) Learning resources (3) Collaboration center (4) Cognitive tools center (5) Creative thinking center (6) Scaffolding and (7) Coaching center. The example designing elements were shown as below (see Figs. 6, 7, 8 and 9).

Fig. 6. Designing elements of the constructivist digital learning environment model in First Page and Problem Base.

Fig. 7. Designing elements of the constructivist digital learning environment model in Learning Resources and Collaboration Center.

Fig. 8. Designing elements of the constructivist digital learning environment model in Cognitive Tools Center and Creative thinking center.

Fig. 9. Designing elements of the constructivist digital learning environment model in Scaffolding center and Coaching center.

5 Summary and Conclusion

The results of the synthesizing of designing framework of the constructivist digital learning environment model to enhance creative thinking for undergraduate students comprised of 5 stages as (1) Activating cognitive structure (2) Supporting cognitive equilibrium (3) Enhancing cognitive structure accommodation (4) Enhancing creative thinking and (5) Supporting and fostering knowledge construction. Moreover, 7 components of the model as (1) Problem based (2) Learning resources (3) Collaboration center (4) Cognitive tools center (5) Creative thinking center (6) Scaffolding and (7) Coaching center.

With regard to model components, it believes that Problem based component that used to activate cognitive structure and enhance creative thinking could help students to question or increase their disequilibrium condition. It was designed in the ways of problems presentation in authentic context and the situations that they solved the problems and developed their creative thinking in learning tasks. This was consistent with the study results of Sumalee et al. [10] and Samat and Chaijaroen [11] that designed their problem based to raise cognitive conflicts and cognitive equilibrium. The students thus then search and discovered information from Learning Resources which was consistent with the research outcome of Pornwut and Chaijaroen [12] Moreover, the student's learning with Collaboration Center presented their understanding adjustment while they learned with the center. This was from their cognitive structure accommodation by network technology and social online, which consistent with Samat et al. [13] The center of Cognitive tool that a tool as google drop box was used to support tasks problem solving and then to accommodate cognitive structure. This was also consistent with Techapornpong [14] To enhance student's creative thinking was believed that from Creative Thinking Enhancement Center based on 4 components of Guilford's theory [2] as Fluency, Flexibility, Originality, Elaboration, which was consistent with research result of Chaijaroen et al. [15] On the other hand, if the student themselves could not solve problems in the tasks, Scaffolding center was designed to support and assist them with guideline, suggestion, strategies as well as thinking process which consistent with Chaijaroen and Samat [16] Coaching Center was to a teacher and an expert to notice student learning process and give a hint, monitor, reflect, and assist in order to develop their learning. This was also consistent with Bransford and Vye [17] Suchart [18].

The result of the evaluation of the designing framework was found the validation in design which consistent with the fundamentals used in designing process. This might cause from literature review along with theories and principles analysis that used to synthesize the framework. Since this framework was focused on student's practice of creative thinking through task completion and Creative Thinking center based on Guildford [2] so this designing framework was then able to be used to develop the learning digital environment model.

Acknowledgements. This research was supported by Ph.D. Program in Educational Technology, Faculty of Education, Research Group for Innovation and Cognitive Technology, Khon Kaen, University, and Research and Technology Transfer Affairs Division, Khon Kaen University, and Graduate School, Khon Kaen University which hereby giving the thankfulness all through this.

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User-Centered Design of Mobile Application Model for Academic Library Services

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Abstract. This research aims to develop a model of mobile application based on user-centered design for academic library services in Thailand. The research sample consists of five hundred undergraduate students selected by two-stage sampling according to the universities and the student levels to define the needs. The other sampling group consists of ten experts for evaluating the model. The data collection was conducted through questionnaires and an evaluation form and was analyzed by descriptive statistics such as arithmetic mean and standard deviation. The results revealed that users' needs of services were identified in four groups: circulation service (*Mean* = 3.99), information searching (*Mean* = 3.97), library facilities (*Mean* = 3.87), and library public relations (*Mean* = 3.87). A model was developed from these needs and was then evaluated by the experts. The overall quality is at the highest level (*Mean* = 4.34) whereby the utility (*Mean* = 4.53) and propriety (*Mean* = 4.43) are at the highest level while the feasibility (*Mean* = 4.20) and accuracy (*Mean* = 4.20) are at the high level.

Keywords: Mobile application · Academic library services · User-centered design

1 Introduction

Information and communication technologies have been essential tools for educational change and reform, especially the Internet and mobile technology. Nowadays, smartphones which connect people to the Internet, become a part of our daily life. In 2015, 52.7% of the global mobile phone users accessed the Internet from their mobile phone. This number was expected to grow to 63.4% in 2018 [1]. Smartphones access the Internet via mobile applications that have been developed at an unprecedented pace since Safari apps (iOS 1) appeared in 2008 following the launch of multitouch smartphones [2]. The mobile application requires programs that are different from the traditional software development. It needs a small-size screen display, limited input methods, hardware specification and configuration flexible to different types of mobile operating systems and platforms.

Mobile technology in educational institutes is a convergence of teachers, student, textbooks and information sources through a single mode of access. It provides a convenient tool for learning. Meanwhile, libraries facilitate information access and

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 252–260, 2019.
https://doi.org/10.1007/978-3-030-35343-8_27

have been at the forefront in using the emerging technologies to effectively provide information resources [3]. In the digital era, people prefer information access through websites to traditional libraries. Libraries need to develop mobile technology compatible with the users' behaviors to improve information access and services.

The mobile-based library services have been developed in Thailand via websites and mobile applications. According to Techataweewan [4], accessing the library mobile services through smartphones can be done in three ways: (1) the university's mobile applications, (2) the library's mobile applications and (3) the library's responsive webs. The mobile services are OPAC (Online Public Access Catalogs), online databases, digital library, loans, reference service, news and events, study room reservation, book suggestion, and book location. The obstacles of application development are a lack of programmers, ideas and budget. If a library tries to meet the users' needs for mobile service, a user-centered design for library application is essential for success. These services enhance the user's personalized experience that truly changes the library as mentioned in Zhu and Zhang [5] that "where there are users, there is service".

Mobile application has been developed significantly to support the growing numbers of smartphone users. There are many models of mobile development solutions. The popular software process models are Built-and-Fix Model, Waterfall Model, Incremental Model, Spiral Model, JAD (Joint Application Development), RAD (Rapid Application Development), Agile Methodologies, Prototyping Model, and UP (Unified Process) [6, 7]. Mobile application development integrates the modern models that alter the weakness of the structure design to have a more concise workflow and faster system development such as RAD and Prototyping models. The development models initialize the planning for system design by analyzing requirements and feasibility. Mobile application development that follows a user-centered design process in real-life context is a significant process [8]. Therefore, this paper focuses on the rapidly developing models to study functional users' requirements of a mobile application for academic library services.

2 Objectives

This paper investigates the needs of library services through mobile application based on user's involvement as a user-centered design as well as developing a model of academic library mobile application and evaluating the model.

3 Methodology

The research employed a quantitative method. The sampling group was divided into two groups, five hundred undergraduate students from ten universities selected by two-stage sampling method: universities and students. The sampling group was used for defining the users' requirements. The other group consisted of ten experts in library science, information technology, computer science and education by purposive sampling. The research tools were a questionnaire and an evaluation form using five-point

Likert's scale. The evaluation form was derived from the program evaluation standards of the Joint Committee on Standards for Educational Evaluation [9] in four standards such as utility, feasibility, propriety, and accuracy. Five experts considered the content validity of the tools with IOC between 0.60–1.00. Forty-one undergraduate students tried out the questionnaire which analyzed the reliability using Cronbach's alpha coefficient of 0.90.

The data were collected from ten universities with the assistance of the academic librarians with a total of 500 participants, 339 females (67.80%) 160 males (32.00%) and one unknown gender (0.20%). Among the participants, 425 students (85.00%) mostly used smartphones where 249 students used Android (49.80%) and 238 students used iOS (47.60%). Their average time of using smartphones was 6–8 h per day (49.00%) and 399 students used smart phones for entertainment (79.80%). Data about the needs of the mobile application were analyzed with descriptive statistics such as arithmetic mean and standard deviation.

The research result from the questionnaire was synthesized to develop a model of a mobile application for library services as the needs of users. Ten experts consisted of academic library executives and faculty staff in ICT, evaluated the model in four aspects: utility, feasibility, appropriateness, and accuracy. Data were also analyzed with arithmetic mean and standard deviation.

4 Results

The model of mobile application of academic library services as the users' expected needs can be divided into four service groups: the circulation services (*Mean* = 3.99), information searching (*Mean* = 3.97), library facilities (*Mean* = 3.87) and library public relations (*Mean* = 3.87) respectively, as shown in Table 1. The circulation services consisted of renewal, book reserve, My Account, late notifications/late fees, reserve book notification, book loss report, and e-book loan. The information searching consisted of the online public access catalog (OPAC), reserved books, e-books/e-journals, database search instructions, full texts/other source links, book location and book delivery. The library facilities consisted of the reference service, library map or floor plans, audio books, social media link, room reservation, speech recognition, and automatic notification. The library public relations consisted of About us, open hours, News & Events, services and facilities guides, new book suggestion, feedback, and information via QR code.

The needs of users were applied to be the functional design of mobile application for academic library service. The following Fig. 1 is use case diagram of the mobile application model for library services represents the relations of service functions in four groups. About library refers to the library public relations that provide the necessary information and FAQ for users such as about the library, open hours, news and events, map and floor plans, services and facilities guides, reception of recommendation and feedback, new books suggestion, contact, and so on which can present via QR code. A search is a group of information searching, especially searching the library catalog called OPAC and online databases of electronic resources. In additional WorldCat is the world union library catalog that about 17,900 libraries in 123 countries

Table 1. The users' needs of the library mobile application for academic library services

Mobile library services	*Mean*	*SD*	Need level
1. Library Public Relations (About Library)			
1.1 About us	3.88	1.07	High
1.2 Open hours	4.18	1.07	High
1.3 News & events	3.78	1.15	High
1.4 Services and facilities guides	4.03	1.11	High
1.5 New books suggestion	3.88	1.20	High
1.6 Recommendation/Feedback	3.73	1.20	High
1.7 Information via QR code	3.59	1.17	High
Total	3.87	0.95	High
2. Information Searching (Search)			
2.1 OPAC	4.02	1.16	High
2.2 Reserved book searching	3.85	1.26	High
2.3 E-books/e-journals	3.98	1.12	High
2.4 Information search instruction	3.99	1.11	High
2.5 Full text/other information source links	3.94	1.14	High
2.6 Book location	4.11	1.16	High
2.7 Book delivery	3.94	1.21	High
Total	3.97	0.99	High
3. Circulation Service (My Account)			
3.1 Renew borrowing	4.06	1.17	High
3.2 Book reservation	3.94	1.21	High
3.3 My account	4.05	1.12	High
3.4 Late notification/late fees	4.10	1.14	High
3.5 Reserve book notification	3.93	1.24	High
3.6 Book lost report	3.92	1.20	High
3.7 E-book loan	3.93	1.19	High
Total	3.99	1.04	High
4. Other Library Facility (Online Services)			
4.1 Reference service	4.00	1.19	High
4.2 Library location/floor plans	3.95	1.27	High
4.3 Audio books	3.77	1.22	High
4.4 Social media links	3.81	1.17	High
4.5 Room reservation	4.03	1.19	High
4.6 Speech recognition	3.69	1.25	High
4.7 Automatic notification	3.82	1.23	High
Total	3.87	1.03	High

cooperatively contribute, enhance and share bibliographic data. My Account refers to a user involved with library information resources use preferably the circulation and reading services. The last group is the online services provide the convenience for studying, researching and self-learning to the users without entrance to the library places. The diagram was applied to the prototype of the library mobile application to present to ten experts for evaluating the model (Fig. 2).

The model of the mobile application for academic library services include four groups such as library public relations (About Library), information searching (Search), circulation service (My Account), and library facilities (Online Services). The model was evaluated by the experts. The overall result is the highest level of quality (*Mean* = 4.34) which are the utility (*Mean* = 4.53) and propriety (*Mean* = 4.43) at the highest levels while the feasibility (*Mean* = 4.20) and accuracy (*Mean* = 4.20) are at the high level (Table 2).

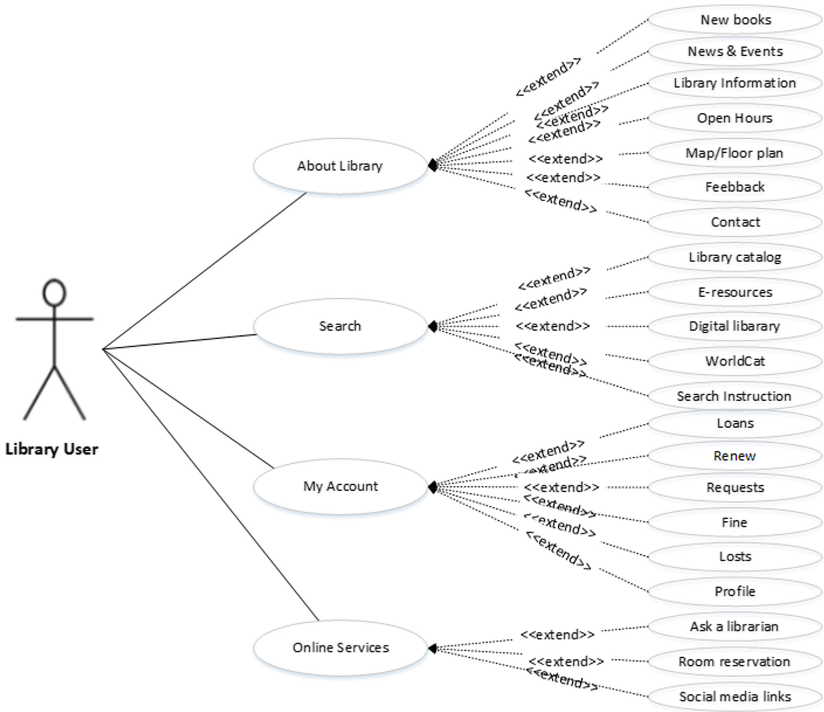

Fig. 1. The diagram of functional design of mobile application for academic library service

Table 2. The evaluation of the mobile application model for academic library services

Evaluation items	*Mean*	*SD*	Quality level
Utility			
1. The model can be used as a guideline for improving library services	4.70	0.46	Highest
2. The model is applicable and worthwhile to the library	4.50	0.50	Highest
3. The model is useful for library users	4.40	0.49	Highest
Total	4.53	0.02	Highest
Feasibility			
4. The model is feasible for the library	4.40	0.49	Highest
5. The details can be understood and applied	4.30	0.46	Highest
6. Following the model makes the library fully mobile	3.90	0.70	High
Total	4.20	0.11	High
Propriety			
7. The model is suitable for academic library	4.50	0.50	Highest
8. The model is appropriate for the library staff to apply	4.40	0.49	Highest
9. The model is appropriate for the academic library users	4.40	0.49	Highest
Total	4.43	0.05	Highest
Accuracy			
10. The model is accurate and reliable	4.10	0.83	High
11. The model contains clear and accurate illustrations	4.20	0.75	High
12. The texts are explanatory and clear	4.30	0.64	Highest
Total	4.20	0.08	High
Overall	4.34	0.12	Highest

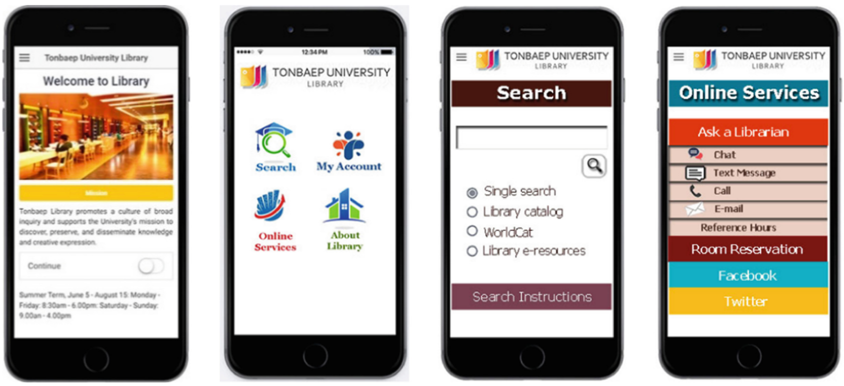

Fig. 2. The prototype of library mobile application

5 Conclusion and Discussion

The findings of this study revealed the model of library mobile application according to the users' needs or expectations. The students need the circulation as a primary service because it is the main service of the library. The students can take out books to read or study at home in both physical and digital format. The second need is the information searching service because it is an access tool and resource guide to the collection of libraries, e-resources of the library, digital resources, and open access contents available on the Internet. The academic libraries presently use the single search software and application to provide the user's search information in the same interface. Those results are according to the studies of Bisshop [10], Bomhold [11], Dresselhauls and Shorode [12], Hung and Chan Lin [13], Iyabodem, Adetoro, and Eniola [14], Jackson [15], Kumar [16], Li [17], Sanguansak [18], Thomas [19], Wang, Ke, and Lu [20], and West et al. [21].

The students also need library public relations to notify them about the necessary information involved in their student life such as hours of operation, news and activities, location and contact, service guide and new arrivals. Therefore, they need another section about the library facilities. The online reference service allows fast response for questions and answers between the library staff and patrons with the present communication technology such as Line, Facebook, Messenger, and online chat or request box of the library website. Furthermore, the library can send a short message to inform and notify the individual user or group users via the Internet. It reduces costs and time for connecting between the library and users.

The mobile application can facilitate the reservation of study room in the library, book suggestion, book location, etc. This will make the library services more convenient. The results of mobile library public relations and facilities are according to the studies of Bomhold [11], Hung and Chan Lin [13], Jackson [15], Kumar [16], Li [17], Wang, Ke, and Lu [20], Hahn [22], Hahn and Morales [23], Kwiecien [24], Paterson and Low [25], Pu [26], Shattle, Holdsworth, and Lee [27], and Wilson and McCarthy [28]. The quality evaluation of the model is at the highest level, especially the utility and propriety aspects are at the highest level. It can be applied to enhance the library services on the emerging mobile platforms. The lowest mean scores of evaluation item is "Following the model makes the library fully mobile." This means the functions or services of academic library need more innovation to keep up with the changes in users' needs.

Acknowledgments. This research was financially supported by Strategic Wisdom and Research Institute, Srinakharinwirot University, Bangkok, Thailand.

Conflict of Interest. The authors declare that there is no conflict of interest regarding the publication of this paper.

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Theoretical Framework of Constructivist Web-Based Learning Environment Model to Enhance Mathematical Problem Solving

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Abstract. The purpose of this research was to synthesize theoretical framework of constructivist web-based learning environment model to enhance mathematical problem solving. The design and development research model is employed in this study. The research procedure consists of four main steps: first step document analysis and examination of learning and teaching context. Second step examining and analyzing the related principles and theories such as learning theory, constructivist theories, mathematical problem solving, media theory, and technology. Third step to study instructional context. The fourth step to synthesize the theoretical framework. The result revealed that: the theoretical framework consisted of 7 bases were as follows: (a) Basic contextual: (i) the education core curriculum, (ii) basic mathematics belong learning area of mathematics in secondary high school, (ii) context for high school mathematics learning focused on thinking and mathematical process skills for higher education. (b) Basic of mathematical problem solving: (i) how to solve it of Polya, (ii) problem solving of Krulik and Rudnick (c) Basic teaching sciences: (i) constructivist theory is cognitive constructivism and social constructivism, (ii) cognitive Theory is information processing theory, schema theory, mental model theory, metacognition theory and cognitive load theory. (d) Basics of learning psychology of constructivist learning environment model: (i) OLEs model, (ii) CLEs model, (iii) SOI model, (iv) cognitive apprenticeship, (v) situated learning. (e) Foundations of media theory: (i) media symbol system, (ii) learning with multimedia. (f) Fundamentals of technology: (i) web-based learning environment, (ii) Facebooks, Line, Google Classrooms. (g) Basic of neuroscience.

Keywords: Theoretical framework · Learning environments model · Technology on Web-based · Constructivist theories · Mathematical problem solving

1 Introduction

The changing of world society and advancement of technology is influenced society in globalization. This change affects human being need to learn all their life or life- long learning, especially 21 century learning focuses on learning and problem solving skills.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 261–267, 2019.
https://doi.org/10.1007/978-3-030-35343-8_28

However, at present instructional management focuses on transmitting and memorizing information. This results in lacking of problem solving seeking skills of the learners [1].

Above mentioned reasons, it is necessary to adapt the learning strategies to meet the 21 century learners' characteristics. Therefore, the instruction design must be changed in order to foster problem solving and knowledge construction rather than passively receive the knowledge. Instructional design theory (ID Theory) was used in this design. [2], Self-construct learning is important in linking experiences with new knowledge apply to solve the problem effectively. Learning methods and including innovation need to be adjusted to be consistent with the child center. Learners seek knowledge and construct learning. It's not just about teaching students to remember what they have learned but develop the attributes that the learner wishes for continuous and lifelong learning can compete and collaborate creatively in Thai society and the world. [3], Crucial theories used as foundation was constructivist theories: social constructivism and cognitive constructivism, cognitive theories: information processing, schema theory, mental model theory, metacognition theory and cognitive load theory. [4], these theories may help the knowledge construction and mathematical problem solving of the learners [5], especially in the multimedia production and presentation for education. Moreover, the media attribute and symbols system of web base comprises of hypertext, hyperlink, and hyperlink media may support the knowledge construction and mathematical problem solving [6].

Mathematics is a very important subject for the development of people in the country. Mathematical knowledge is fundamental to thinking, creating, knowledge and work. Learning to have students mathematical knowledge: especially problem solving in mathematics. Learners must use their knowledge and experience in mathematics and other science with the ability to analyze, synthesis and decision making. These skills must be in the student body so that they can be considered as mathematicians. Teaching problem solving in mathematics is teaches students how to solve problems more to teach the learner the answer to the problem. Encourage learners to find patterns or solve problems manually. It is considered to be the focus of the students' thinking skills [7].

For the above reasons, researchers realize the importance of synthesizing the theoretical framework of the constructivist web based learning model to enhance mathematical problem solving. It will help to confirm the mathematical problem solving and provide beneficial guideline for the theoretical the constructivist web based learning environment model. Subsequent paragraphs, however, are indented.

2 Research Methodology

This research is the first phase of the Model research [8], which focuses on the document analysis and survey research was employed of the constructivist web-based learning environment with augmented reality to enhance mathematical problem solving for design process and model development. The process consists of (1) document analysis examine the learning, teaching and context, (2) analyze related principles and theories such as learning theory, Constructivist theory, Cognitive theory, Critical thinking, media theory, and technology, designing of Constructivist web-based learning environment model to enhance Critical thinking, (3) synthesize the theoretical framework. The document analysis and survey were used.

2.1 Research Objectives

The purpose of this research was to synthesize theoretical framework of constructivist web-based learning environment model to enhance mathematical problem solving.

2.2 Target Group

The target groups of this study consisted of 3 experts to assess the theoretical framework of the constructivist web-based learning environment model to enhance mathematical problem solving.

2.3 Research Instruments

The instruments in this study consisted of 2 instruments as following:

- A synthesis of theoretical framework record form for recording the analysis of document and related research of the web-based learning environments model to enhance the learner's mathematical problem solving.
- The experts' assessment form for assessment the quality of the theoretical framework of the web-based learning environments model to enhance the learner's mathematical problem solving.

2.4 Data Collecting and Analysis

To obtain the theoretical framework, related principles and theories and documents were analyzed and synthesized by using summarization, interpretation and analytical description. The experts' assessment concerning the designing of the learning environment model was analyzed by using summarization, interpretation and analytical description.

3 Research Results

Theoretical framework of constructivist web-based learning environment model to enhance mathematical problem solving consisted of 7 bases were as follows: 1) Basic contextual: (1) the education core curriculum, (2) basic mathematics belong learning area of mathematics in secondary high school, (3) context for high school mathematics learning focused on thinking and mathematical process skills for higher education. 2) Basic of mathematical problem solving: (1) how to solve it of Polya, (2) problem solving of Krulik S. & Rudnick. 3) Basic teaching sciences: (1) constructivist theory is cognitive constructivism and social constructivism, (2) cognitive Theory is information processing theory, schema theory, mental model theory, metacognition theory and cognitive load theory. 4) Basics of learning psychology of constructivist learning environment model: (1) OLEs model, (2) CLEs model, (3) SOI model, (4) cognitive apprenticeship, (5) situated learning. 5) Foundations of media theory: (1) media symbol system, (2) learning with multimedia. 6) Fundamentals of technology: (1) web-based learning environment, (2) Facebooks, Line, Google Classrooms. 7) Basic of neuro-science. (see Fig. 1).

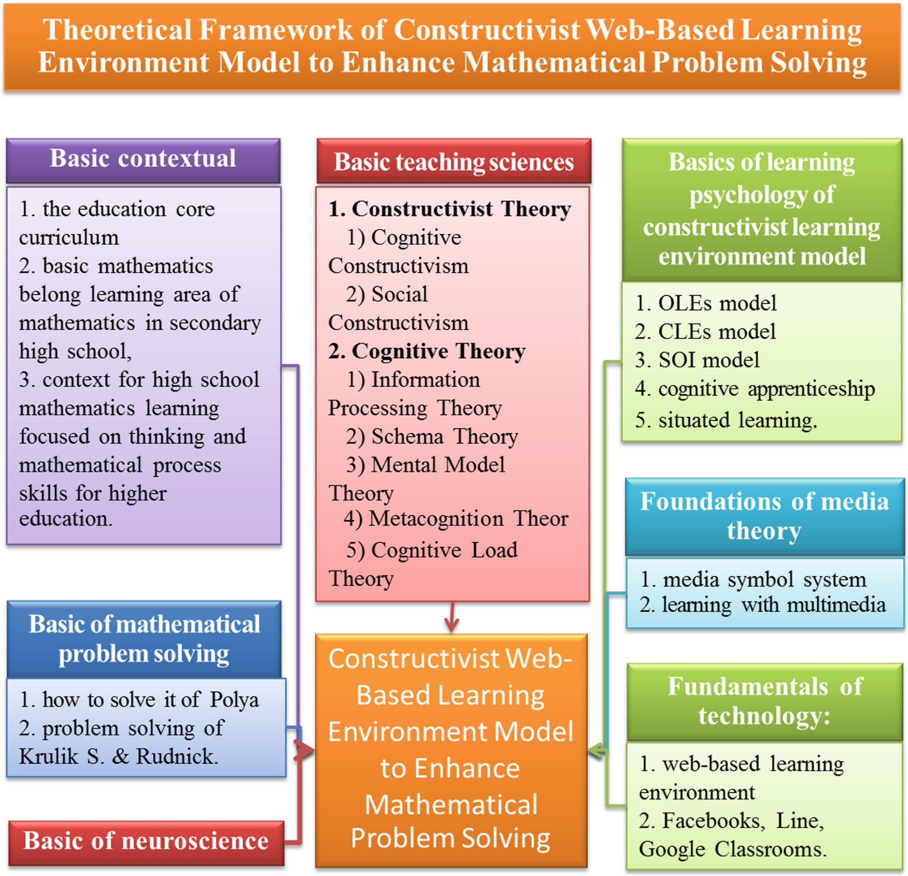

Fig. 1. Theoretical framework of constructivist web-based learning environment model to enhance mathematical problem solving.

4 Discussion

Theoretical framework of constructivist web-based learning environment model to enhance mathematical problem solving consisted of 7 bases were as follows: 1) Basic contextual: (1) the education core curriculum (2) basic mathematics belong learning area of mathematics in secondary high school (3) context for high school mathematics learning focused on thinking and mathematical process skills for higher education. [9]. 2) Basic of mathematical problem solving: (1) How to solve it of Polya [10],

(2) Problem solving of Krulik S & Rudnick [11]. 3) Basic teaching sciences (1) constructivist theory is cognitive constructivism [12], and social constructivism [13], (2) cognitive Theory is information processing theory [14], schema theory, mental model theory, metacognition theory and cognitive load theory [15]. 4) Basics of learning psychology of constructivist learning environment model: (1) OLEs model [16], (2) CLEs model [17], (3) SOI model [18], (4) cognitive apprenticeship [19], (5) situated learning [20]. 5) Foundations of media theory: (1) media symbol system (2) learning with multimedia [21]. 6) Fundamentals of technology: (1) web-based learning environment (2) Facebooks, Line, Google Classrooms. [22]. 7) Basic of neuroscience. [23]. Which is consistent with the research of the conceptual framework for designing and developing a learning environment on theoretical, constructivist, and web-based learning. This was shown in the theoretical framework of the Constructivist web-based learning environments model to enhance mathematical problem solving. This may help learners to foster mathematical problem solving. In addition, the theoretical validity of the designing framework of the Constructivist web-based learning environment model was found by experts reviewed. As mentioned findings can be supported the designing framework of the constructivist web-based learning environment model to enhance mathematical problem solving. The designing framework of the Constructivist web-based learning environments model was recognized as the important one. Since it can support and help the designers to design effectively and clearly. If lacking of this theoretical framework how can the designer perform it effectively [24].

5 Conclusion

Theoretical framework of constructivist web-based learning environment model to enhance mathematical problem solving consisted of 7 bases were as follows: 1) Basic contextual: (1) the education core curriculum (2) basic mathematics belong learning area of mathematics in secondary high school (3) context for high school mathematics learning focused on thinking and mathematical process skills for higher education. 2) Basic of mathematical problem solving: (1) How to solve it of Polya, (2) Problem solving of Krulik S. & Rudnick. 3) Basic teaching sciences (1) constructivist theory is cognitive constructivism, and social constructivism, (2) cognitive Theory is information processing theory, schema theory, mental model theory, metacognition theory and cognitive load theory. 4) Basics of learning psychology of constructivist learning environment model: (1) OLEs model, (2) CLEs model, (3) SOI model, (4) cognitive apprenticeship, (5) situated learning. 5) Foundations of media theory: (1) media symbol system (2) learning with multimedia. 6) Fundamentals of technology: (1) web-based learning environment (2) Facebooks, Line, Google Classrooms. 7) Basic of neuroscience.

Acknowledgements. This research was supported by Ph.D. Program in Educational Technology, Faculty of Education, Research Group for Innovation and Cognitive Technology, Khon Kaen, University, and Research and Technology Transfer Affairs Division, Khon Kaen University, and Graduate School, Khon Kaen University which hereby giving the thankfulness all through this.

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The Designing Framework of Constructivist Learning Environment Model to Enhance Information Processing and Reduce Cognitive Load for Students' Primary Grade 5

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Abstract. Information processing is the process which occurs in human thinking process. It concerns Information processing procedures and information retrieval from long-term memory. Research purpose was to synthesize designing framework of the constructivist learning environment model to enhance information processing and reduce cognitive load for students' primary grade 5. Model research type was employed by document analysis to synthesize theoretical and designing frameworks. The qualitative data was collected and analyzed by summarizing, interpreting, and method of descriptive analysis. The target groups comprised 9 experts and 30 students each from Anubankhonkaen school, Demonstration of School Khon Kaen University, Elementary Division, and Modindaeng Demonstration School Khon Kaen University, Elementary Division. The data was collected by the following (1) principles and theories study (2) literature review (3) designing framework synthesizing based on information processing principle of Klausmeier (1985) and cognitive load reducing of Sweller (2011). The research results were found that its designing framework comprised 4 processes as (1) Activating cognitive structure and enhancing information processing along with reducing cognitive load (2) Supporting cognitive equilibrium and enhancing information processing along with reducing cognitive load (3) Enhancing knowledge construction and enhancing information processing along with reducing cognitive load and (4) Supporting and fostering knowledge construction. It as well consisted of 7 components as (1) Problem base (2) Vocabulary Bank (3) Brainstorming center (4) Information processing enhancing and cognitive load reducing center (5) Cognitive tool center (6) Scaffolding center and (7) Coaching center.

Keywords: Web-Based learning · Constructivism · Information processing · Cognitive load reducing

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 268–277, 2019.
https://doi.org/10.1007/978-3-030-35343-8_29

1 Introduction

In the considerable changing trend of globalization era, it is the ear of information and communication including learning resources which continuously increasing. To be in such globalization and industrial 4.0 era, Thailand has to drive and be ready in multiple aspect especially in education. Learners should be given an opportunity to receive knowledge and skills, however, a foreign language is one that rather be focused on. New knowledge that comes with new technology makes it unlimited, so that learning should be developed in the way to activate the learners to be able to process information; and to emphasize on them.

In according with such changes, some influence learning problems in Thailand. It was found the average of the test result of O-NET in 2016 of English language of grade 6 students at 34.59 scores [1]. Moreover, the survey by Education First (EF) about English language index in English use of Thai people revealed that in 2017 Thai was in the 56th of the world [2] and the Placement Test results of Education First (EF) found that the Thai student was at 53rd out of the total 54 countries which in very low proficiency level [3]. This means Thai people need to improve English language skills. Besides, learners face with lacking of knowledge discovery and rote learning which cause them to unable to construct their own knowledge. Once they do not have a chance to rote, they finally forget what they learned. In order to solve this problem, leaning paradigm should change from teacher center that only transmits content, to student-center. Human should considerably develop their learning to get ready for the competition in learning societies, which discovery learning by students themselves and teacher's guidelines as well as designed self-evaluation is 21st Century Skills.

An important method to improve student's attributes for that change is to bring related pedagogical principles and theories as Constructivism theory which believes in self-knowledge construction. Also, Cognitivism that focuses on information processing on memorizing, storing, and retrieving information in long term memory, especially English vocabulary that learners are not familiar and it is the fundamental to create sentences then. If they cannot remember words, they will not be able to construct a sentence. Cognitive load theory [4] as comprised Worked example principle and Completion principle that the design is mainly about how to decrease cognitive load while processing information in working memory that over the limit or 7 ± 2 in only 15–30 s.

Furthermore, media attributes and media symbol systems that are presented in hypermedia and hypertext which their text, pictures, sound, animation, videos, and description sound influence the information processing steps by retrieving information in long-term memory. For instance, hypermedia is one pattern of data accessing which connects knowledge nodes from various resources, if the learners lack of sufficient knowledge, it can help them to discover knowledge and find more and deeper information. In addition, media attributes can be presented in all kinds of pictures, sound, and animations which its connection helps their reducing of cognitive load and information processing.

All mentioned above, the researcher realizes the necessary of this challenge, hence studied the design and development of the designing framework of constructivist learning environment model to enhance information processing and reduce cognitive load for students' primary grade 5.

2 Research Purpose

To synthesize the designing framework of the constructivist learning environment model to enhance information processing and reduce cognitive load for students' primary grade 5.

3 Research Methodology

Various methods were employed in the study as Document analysis and Survey method.

3.1 Target Group

The target groups comprised (1) 2 experts for the model content evaluation (2) 3 experts for the media quality evaluation (3) 3 experts for model designing and (4) 3 experts for the evaluation of collecting data instruments (5) 1 model designer for being evaluated his characteristics that affected model design (6) 1 model developer for being evaluated his characteristics that affected model development and (7) 2 English teachers for being evaluated his characteristics that affected model design. They are also included 30 students from primary grade 5 of Anubankhonkaen school, 30 students from Demonstration of School Khon Kaen University, Elementary Division, 30 students from Modindaeng Demonstration School Khon Kaen University, Elementary Division who registered in English subject of semester 1 academic year 2019.

3.2 Research Instruments

- Recording form for synthesize the designing framework of constructivist digital learning environment model to enhance Information Processing and Reduce Cognitive Load for Students' Primary Grade 5.
- Evaluation form for the experts used in designing framework of constructivist digital learning environment model to enhance Information Processing and Reduce Cognitive Load for Students' Primary Grade 5 evaluation.

3.3 Data Collection and Data Analysis

The data was collected for the framework synthesis as in the following. (1) The literature review and related researches as learning theories: Constructivism, Cognitivism, Pedagogical theories, and web-based learning were analyzed and used as a fundamental of the theoretical and designing frameworks for this study. Such data was recorded in the recording form of the synthesizing of the theoretical and designing frameworks by the methods of interpreting and descriptive analysis. (2) The recording form of the designing framework synthesis was used to review literature and related researches of the constructivist learning environment model to enhance information processing and reduce cognitive load for students' primary grade 5 as well to be basement for the theoretical framework. This was conducted by methods of interpreting and descriptive analysis. (3) The designing framework then was developed based on the theoretical framework which stated principles and theories of information processing and cognitive load reducing as well as model components by interpreting and descriptive analysis. It hence was proposed to the research advisor and the designing experts to evaluate and examine the consistency among those principles. Their evaluation results and recommendations were finally applied.

4 Research Results

The results of the synthesis of the designing framework of the designing framework of constructivist learning environment model to enhance information processing and reduce cognitive load for students primary grade 5 consisted of 4 important procedures as (1) Activating cognitive structure and enhancing information processing along with reducing cognitive load (2) Supporting cognitive equilibrium and enhancing information processing along with reducing cognitive load (3) Enhancing knowledge construction and enhancing information processing along with reducing cognitive load and (4) Supporting and fostering knowledge construction as the following detail.

4.1 Activating Cognitive Structure and Enhancing Information Processing Along with Reducing Cognitive Load

Activating cognitive structure and enhancing information processing along with reducing cognitive load. The first fundamental of the designing framework is Activating cognitive structure and enhancing information processing along with reducing cognitive load which based on cognitive constructivism theory [5] that believes that the learner should be provoked by a problem and leaded to cognitive conflict; Situated learning principle [6] which emphasizes on authentic situations. The tasks were designed as authentic learning task while the designed problem based was used to activate students' disequilibrium. Furthermore, SOI model principle [7] which comprised three processes as Selecting, Organizing, and Integrating; and Information Processing principle [8] based on three cognitive processes as Sensory Register, Short-term memory, and Long-term memory with information retrieval were used as this research basement.

Moreover, another theory used is Cognitive load theory [4] comprised (1) Worked example principle suggests replace conventional tasks with Worked examples that must be carefully studied by the learners. Because learners study rather than generate solution, this reduces the high extraneous load caused by weak problem-solving methods and (2) Completion principle suggests replace conventional tasks with completion tasks that provide a partial solution learners must finish, which provide a partial solution that must be completed by the learner. Like worked example, completion tasks reduce extraneous load caused by weak problem-solving methods because giving part of the solution reduces the size of the problem space. Which focused on the design that reduces cognitive load while processing information in working memory based on human limitation of information processing as 7 ± 2 in short 15–30 s. All mentioned, this was to design the model component as **Problem Base** (see Fig. 1).

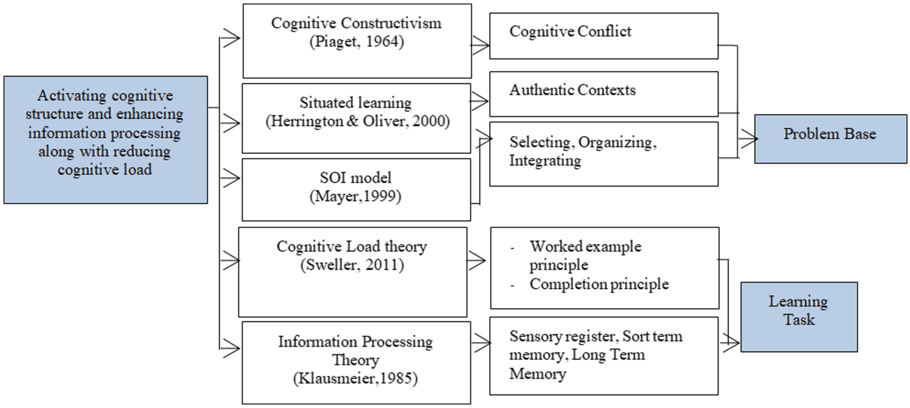

Fig. 1. Theoretical framework designing problem base.

4.2 Supporting Cognitive Equilibrium and Enhancing Information Processing Along with Reducing Cognitive Load

Supporting cognitive equilibrium and enhancing information processing along with reducing cognitive load. When a student is provoked by a problem and is in cognitive disequilibrium condition, he must be supported to be able to adjust to cognitive equilibrium condition. They search and discover information in Vocabulary Bank to be used in assimilation or accommodation processes. In designing process, the researcher used various theories as Information Processing [8] which focuses on Sensory Register, Short-term memory, and Long-term memory with information retrieval were used as this research basement; Cognitive load theory [4] as (1) Worked example principle and (2) Completion principle which mainly about reducing cognitive load of the vocabulary in over limitation; and SOI model [7] which encourages students to select, organize, and integrate. The most important theory is Information Processing [8] which mainly on its design to foster students' attention as emphasizing bold, italic, underline text, highlight text, and animation text as well as design that help them to connect prior and new knowledge in their long-term memory. was part of this process to design its component Vocabulary Bank (see Fig. 2).

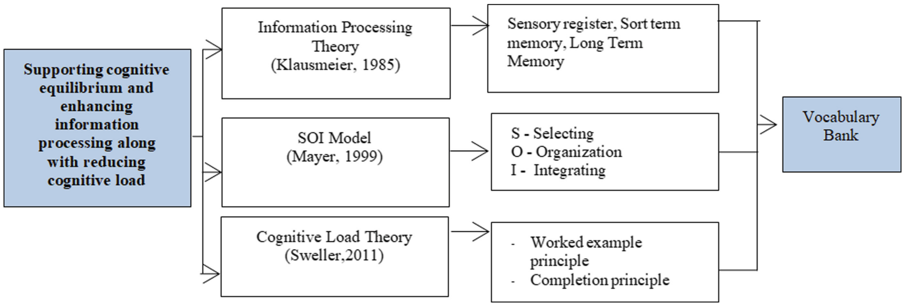

Fig. 2. Theoretical framework designing Learning Resources.

4.3 Enhancing Knowledge Construction and Enhancing Information Processing Along with Reducing Cognitive Load

Enhancing knowledge construction and enhancing information processing along with reducing cognitive load. Social constructivism) [9] was the basement of this aspect that highlighted on the collaboration in social, language, and culture which influences students' cognition and their social interaction. Brainstorming center was then designed to help students to share their multiple perspectives inside and outside classroom whenever they want throughout Web board, Facebook, Line, and email. Center of information processing enhancing and cognitive load reducing is a center based on Cognitivism theory [8] that enhance students to store memory based on the processes of (1) Sensory register (2) Short-term memory and (3) Long-term memory. It was designed in task activity that encourages students to practice in information processing enhancing in three processes as sensory register, short-term memory and (3) Long-term memory. Also, Cognitive load theory [4] which comprised (1) Worked example principle and (2) Completion principle that focuses on the design that reduces students' cognitive load while processing information with their limitation of working memory. Cognitive tools center was designed based on the studies [10] that proposed cognitive tools as (1) Seeking tool-used to support students in discovering related information and identify where it is located by using search engines as Google and Youtube (2) Collecting tool-help them to store information by downloading (3) Organizing tool-help them to categorize information and connect related information and (4) Communicating tool-assist the students to communicate, discuss, and share their perspectives among students, teachers, and experts by using Facebook, Line, and Email (see Fig. 3).

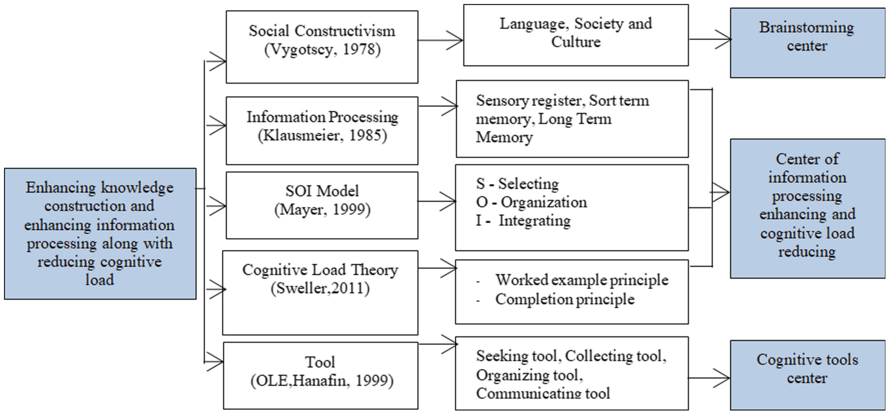

Fig. 3. Theoretical framework designing Brainstorming center, Center of information processing enhancing and cognitive load reducing and Cognitive tools center

4.4 Supporting and Fostering Knowledge Construction as the Following Detail

Supporting and fostering knowledge construction. This aspect was based on social constructivist theory [9] who believes that the learners have learning limitation or in Zone of proximal development. If they are under the zone, they are needed to be assisted to adjust their accommodation and assimilation. Scaffolding center was hence developed to consist of 3 basements as 1. Sensory register scaffolding 2. Short-term memory scaffolding 3. Short-term memory scaffolding. On the other hand, Coaching center was designed based on the findings that the learning that focuses on self-knowledge construction may cause misconceptions, so Cognitive apprenticeship [11] that emphasizes the expertizing of model can help them. Methods of demonstration or examples with explanation for English vocabulary storing in memory can help them to be able to use words then. The coach helped them to adjust their misconceptions (see Fig. 4).

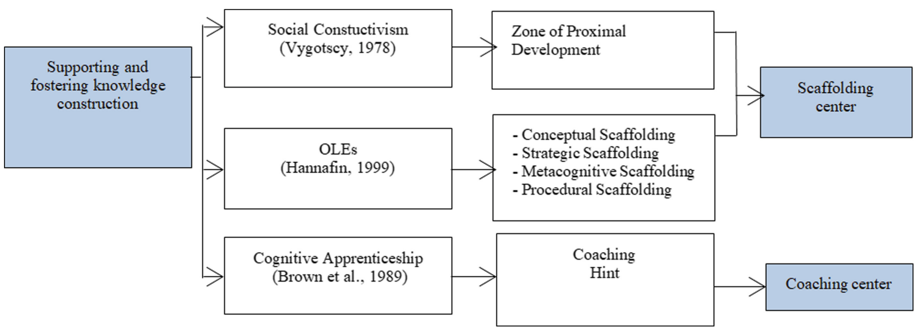

Fig. 4. Theoretical framework designing Scaffolding center and Coaching center.

The evaluation of the experts towards the designing framework was found the validation of consistency on every theory which comprised (1) context based (2) learning psychology based (3) pedagogical based (4) media and technology based 5) Information processing theory and Cognitive load theory based and (5) neuroscience based. Those bases hence were used to design the model component as there are 7 components as (1) Problem based (2) Vocabulary Bank (3) Brainstorming center (4) Center of information processing enhancing and cognitive load reducing (5) Cognitive tools center (6) Scaffolding center g and (7) Coaching center. As an example designing elements (see Figs. 5, 6, 7, 8).

Fig. 5. Designing elements of the Constructivist Learning Environment model in Main Page and Problem Base

Fig. 6. Designing elements of the Constructivist Learning Environment model in Vocabulary Bank and Brainstorming center

Fig. 7. Designing elements of the Constructivist Learning Environment model in Center of information processing enhancing and cognitive load reducing and Cognitive tools center

Fig. 8. Designing elements of the Constructivist Learning Environment model in Scaffolding center g and Coaching center

5 Conclusion and Discussion

The results of the synthesizing of the Constructivist learning environment model to enhance information processing and cognitive load reducing comprised four procedures as (1) Activating cognitive structure and enhancing information processing along with reducing cognitive load (2) Supporting cognitive equilibrium and enhancing information processing along with reducing cognitive load (3) Enhancing knowledge construction and enhancing information processing along with reducing cognitive load and (4) Supporting and fostering knowledge construction. Its components consisted of (1) Problem base (2) Vocabulary Bank (3) Brainstorming center (4) Information processing enhancing and cognitive load reducing center (5) Cognitive tool center (6) Scaffolding center and (7) Coaching center. This was consistent with a research of Parama and Sumalee [12] that studied the framework of learning environment model to enhance information processing by integrating between pedagogy and neuroscience and the researches of Oravan and Sumalee [13], Somabut and Lertsena [14] Chaijaroen, Kwangmuang, Samat, Kanjug, and Somabut [15] and Kwangmuang, Chaijaroen, Samat, and Kanjug [16] that studied the theoretical and designing frameworks which found out that the framework consisted of (1) Activating cognitive structure and Information Processing and Reduce Cognitive Load (2) Supporting cognitive equilibrium (3) Enhancing knowledge construction and Information Processing and Reduce Cognitive Load and (4) Supporting and fostering knowledge construction. Moreover, the results of the framework evaluation revealed the obvious consistency of principles and theories. The study of literature review for model synthesizing may influence such consistency which leads to the effectiveness of the design and development of the learning model.

Acknowledgements. This research was supported by Ph.D. Program in Educational Technology, Faculty of Education, Research Group for Innovation and Cognitive Technology, Khon Kaen, University, and Research and Technology Transfer Affairs Division, Khon Kaen University, and Graduate School, Khon Kaen University which hereby giving the thankfulness all through this.

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Underpinning Knowledge and Skills for Educators to Enhance Cyber Safety Awareness in South African Schools

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Abstract. It is important to start from an early age to educate cyber users about cyber safety so that the cyber users can be cyber safety aware. It would then be the right step to take in educating cyber users already at school level. Out of research done it was clear that the educators in South African schools does not have the right resources, knowledge and skills to enhance schools cyber users cyber safety awareness. A scoping review was performed to identify resources to establish the knowledge areas and skills that the educators need to enhance the cyber safety awareness within the South African schools. This research recommends a number of knowledge areas and skills through a proposed theoretical framework that can be used to create and enhance cyber safety awareness.

Keywords: Cyber safety awareness · 21st century skills · Knowledge

1 Introduction

The daily activities of cyber users are being performed by the cyber users automatically in cyberspace without the cyber users paying attention or even knowing how the activities have been completed. Cyberspace have changed the normal way the cyber users are conducting their daily activities such as communicating, using social media, doing shopping and travelling [1]. Cyber users have now new opportunities in using cyberspace and in embarking on these opportunities the cyber users has improved the cyber user's living standards tremendously. However, cyberspace can also expose the cyber users to cyber risks and cybercrimes. The cyber users can be extremely vulnerable to a variety of cyber risks and cybercrimes; such as identity theft, cyber bullying, cyber stalking and phishing [2]. If cyber users are not aware or educated regarding cyber risks and cybercrimes the cyber users can be vulnerable to these risks and crimes [1]. These cyber risks and cybercrimes can be implemented in cyberspace by any cyber user also known as the offender, thus breaking the law [3]. For this reason the cyber users need cyber safety awareness to guide them against cyber risks and cybercrimes [1]. The aim of this research is to determine the knowledge areas and skills that an educator needs to enhance cyber safety awareness of learners (also known as cyber users) within a South African school environment. This research recommends a

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 278–290, 2019.
https://doi.org/10.1007/978-3-030-35343-8_30

number of knowledge areas and skills through a proposed theoretical framework that can be used to create and enhance cyber safety awareness.

2 Literature

To protect the cyber users against the cyber risks and cybercrimes the cyber users need cyber safety awareness to guide them against cyber risks and cybercrimes. It is important to start from an early age to educate cyber users about cyber safety so that the cyber users can be cyber safety aware. It would then be the right step to take in educating cyber users already at school level. From this point onwards, the cyber user will be known as the learner. Sutherland indicated that the major underlying concern is that too many schools lack the equipment and trained educators in computer science [4]. For this reason, it would be very difficult for the educators to educate the learners about cyber safety. Von Solms R and Von Solms S also identified that South African schools lack education initiatives and resources regarding cyber safety, so the learners are becoming more vulnerable to cyber safety attacks. It was acknowledged that the South African schools also do not have a cyber safety curriculum [5]. In a study done by Kritzinger it was indicated that almost 50% of South African schools do not have a cyber safety policy in place [6]. Out of the above research done by the researchers it is vital to acknowledge that much need to be done to get South African schools and the educators cyber safety aware.

3 Method

A scoping review was performed. Scoping reviews are geared towards examining the extent, range and nature of research in a particular field, the focus being on the outcome of the review. Scoping review include work in progress, practitioner reports, credible websites and case studies. Relevant papers for consideration were identified by means of using the following databases: ACM digital library, IEEE Xplore, Scopus and ScienceDirect. A manual search was also conducted using Google search to include business and industry discussions of sufficient quality from publications on the web. The search period had a data limit from 2008–2019. The search criteria included all the keywords as indicated at the keyword section at the beginning of the paper. The search identified 855 relevant resources. Of the 855 resources, only 293 resources were eligible for the research. In addition, 56 of these eligible resources were used in this paper.

4 Proposed Framework for Underpinning Knowledge and Skills for Educators to Enhance Learner's Cyber Safety Awareness in South African Schools

This section provides some guidance on how cyber-safety awareness of learners can be enhance by educators within South African schools, by the identification of the knowledge areas regarding cyber safety and the skills that the educators need.

A theoretical framework was used to identify the knowledge areas of cyber safety and the skills that is essential for the educators. The following section will provide information on previous research that was done using digital literacy model.

4.1 Previous Research

The theoretical framework; that consist of the digital literacy model designed by Jahoor was used and adopt to the theoretical framework used in this research [7]. Jahoor use the digital literacy module to identify the skills of educators using technology in rural formal education. Some of the digital literacy model categories can also be applied within this study. The adopted theoretical framework not only used some of the digital literacy model of Jahoor but also includes the 21-st century skills. The 21-st century skills includes the following skills: critical thinking, creativity, collaboration, communication, information literacy, media literacy, technology literacy, flexibility, leadership, initiative, productivity and social skills. Kritzinger indicate in studies done in 2014 and 2017 that it is vital for educators to have knowledge regarding cyber safety and skills to apply the knowledge. Cyber knowledge together with skills will enhance cyber safety awareness [8, 9]. The proposed theoretical framework is discussed and provided in the next section.

4.2 Framework

The proposed theoretical framework is adopted from Jahoor Dimensions Digital Literacy Model [7]. The proposed theoretical framework have three dimensions: technical, social-emotional and cognitive and include literacy for all dimensions. The technical dimension consist of the following categories: operational literacy, ICT literacy and technology literacy. The social-emotional dimension have the following categories: social-emotional literacy, social networking functional literacy, media literacy, online etiquette literacy and cyber safety literacy. Cognitive dimension consist of only one category namely reproduction literacy. The literacy for all dimensions consist of the 21 st century learning skills namely: critical thinking, creativity, collaboration, communication, flexibility, leadership, initiative and productivity. For each of the categories knowledge areas and skills are identified. The knowledge areas and skills are needed for the educators to enhance the learner's cyber safety awareness. The proposed theoretical framework is given in Table 1. An expert review panel will evaluate the reliability and validity of the Theoretical Framework where after the feedback will be used to refine the Theoretical Framework to a usable Theoretical Framework.

Table 1. Theoretical framework.

Dimensions digital literacy model		
Category of digital literacy skills and reference of the category	Knowledge and knowledge reference	Skills
1. Technical dimension 1.1 Operational Literacy F Johoor	Internet safety Technical + Functional Knowledge of ICT in our daily use Example ~ Use & set up of Internet account, Changing info on the Internet, Computers and their use [10, 11]	1.1.1 Motivate safe Internet usage 1.1.2 Monitor safe Internet usage 1.1.3 Communicate safe Internet usage 1.1.4 Communicate the benefits of safe Internet usage 1.1.5 Monitor Internet browser history
	ICT Policy (South Africa) [4, 12–14]	1.1.6 Investigate the content of the ICT Policy 1.1.7 Adapt to use the content (information) within the ICT Policy 1.1.8 Take leadership role and collaborate with policy makers regarding the ICT Policy 1.1.9 Communicate the information within the ICT Policy to your environment 1.1.10 Coordinate the use of the ICT Policy within your environment
	ICT Policy (South Africa – Schools) [2, 14–16]	1.1.11 Investigate the content of the ICT school policy 1.1.12 Adapt to use the content (information) within the ICT school policy 1.1.13 Take leadership role and collaborate with the proper authorities regarding the ICT Policy 1.1.14 Communicate the information within the ICT school policy to your school management and environment 1.1.15 Remain accountable for the safety of the learners regarding the information within the ICT school policy 1.1.16 Coordinate the use of the ICT school policy within your school

(*continued*)

Table 1. (*continued*)

Dimensions digital literacy model		
	Cyber-safety policy (South Africa Schools) [6, 14, 17, 18]	1.1.17 Investigate the content of the cyber safety policy 1.1.18 Adapt to use the content (information) within the cyber safety policy 1.1.19 Coordinate often to make sure that new policies regarding cyber safety is implemented successfully 1.1.20 Promote changes within the cyber safety policy to ensure the safety of the learners 1.1.21 Take leadership role and collaborate with the proper authorities regarding the cyber safety policy 1.1.22 Communicate the information within the cyber safety policy to your school management and environment 1.1.23 Coordinate the use of the cyber safety policy within your school 1.1.24 Review, record and report on cyber incidents to the proper authorities
	Internet policy school [19, 20]	1.1.25 Investigate the content of the Internet policy 1.1.26 Promote changes within the Internet policy to ensure the safety of the learners 1.1.27 Take leadership role and collaborate with the proper authorities regarding the Internet policy 1.1.28 Communicate the information within the Internet policy to your school management and environment 1.1.29 Coordinate the use of the Internet policy within your school
	Cyberbullying policy [21]	1.1.30 Investigate the content of the cyberbullying policy 1.1.31 Adapt to use the content (information) within the cyberbullying policy

(*continued*)

Table 1. (*continued*)

Dimensions digital literacy model		
		1.1.32 Coordinate often to make sure that new policies regarding cyberbullying is implemented successfully 1.1.33 Promote changes within the cyberbullying policy to ensure the safety of the learners 1.1.34 Take leadership role and collaborate with the proper authorities regarding the Cyberbullying policy 1.1.35 Communicate and coordinate the information within the cyberbullying policy to your school management and environment
1.2 ICT Literacy (21 st century skills)	ICT literacy Core knowledge and skills about computers and their use [22]	1.2.1 ICT literacy to be creative in adapting, applying, designing, inventing, or authoring of information 1.2.2 ICT to communicate on knowledge 1.2.3 ICT to collaborate & present on information
1.3 Technology Literacy (21 st century skills)	Integrated technology in the class room [14, 23, 24]	1.3.1 Integrate technology-based education in the classroom 1.3.2 Motivate for the integration of technology in the school curriculum 1.3.3 Ability to use and manage technology in education 1.3.4 Understand why technology is important in education 1.3.5 Embrace proficient digital skills and competencies
2. Social-emotional Dimension 2.1 Social-emotional Literacy F Jahoor	Safe use of the Internet. Online protection. Use Internet appropriately ~ safe use, legal rights, decent behaviour, keep info safe, cyber risks and threats. [25]	2.1.1 Motivation for online self-efficacy (is an individual's belief that they are capable and confident of recognizing and dealing with the risky situation) 2.1.2 Investigate online privacy concerns 2.1.3 Investigate cyber risks

(*continued*)

Table 1. (*continued*)

Dimensions digital literacy model		
		2.1.4 Identify cyber risks Identify and enforcing online privacy concerns 2.1.5 Report cyber risks
F Jahoor	eSafety [26]	2.1.6 Examine learner's eSafety awareness 2.1.7 Identify learners Internet usage patterns, their habits of sharing their surfing experiences with parents and family 2.1.8 Report unsafe use of Internet 2.1.9 Reward learners for being aware of eSafety
F Jahoor	Protecting Information Identity theft [27, 28]	2.1.10 Explores the various types of identity theft 2.1.11 Identify theft incidences 2.1.12 Enforcing save use of Internet to avoid identity theft
2.2 Social Networking Functional Literacy F Jahoor	Social Networks & Media [17, 22, 29]	2.2.1 Use of social networks for collaborative learning and teamwork 2.2.2 Identify positive and negative impact of social networks
2.3 Media Literacy (21 st century skills)	Media literacy and ICT technology Information sourcing, link info and get knowledge Acquiring information [24, 30–35]	2.3.1 ICT in classroom for enhancing 21st century learning skills which included collaboration, communication, information literacy, media literacy, and ICT literacy 2.3.2 Be creative in creating new content information 2.3.3 Share and interact (collaboration) with information by means of using social media 2.3.4 Reflect on social media usages 2.3.5 Reflect on positive and negative media usages
2.4 Online Etiquette Literacy F Jahoor	Etiquette in Technology [36, 37]	2.4.1 Identify good practise of online etiquette 2.4.2 Enforcing online etiquette

(*continued*)

Table 1. (*continued*)

Dimensions digital literacy model		
2.5 Cyber Safety Literacy F Jahoor	Cyber bullying [38–41]	2.5.1 Being aware of cyber bullying 2.5.2 Identify cyber-bullying incidents 2.5.3 Assist learners with copying with cyber bullying 2.5.4 Report on cyber bullying incidents
	Online risk exposure [25]	2.5.5 Understand online risk exposure 2.5.6 Motivate learners for online risk exposure 2.5.7 Assist with online risk exposure incidents 2.5.8 Report online risk exposure incidents
	Inappropriate texting [16, 42]	2.5.9 Understand texting 2.5.10 Dealing with inappropriate texting 2.5.11 Enforce good texting practice 2.5.12 Assist learners with inappropriate texting
3. Cognitive Dimension 3.1 Reproduction Literacy F Jahoor	Use and work with material. Digital agency (DA). Critical thinking for digital info Example: ~ searches, evaluate info (good/bad), recreate info, ethical use of info. [43]	3.1.1 Evaluate the good and the bad regarding digital agency 3.1.2 Recreate information by means of digital agency 3.1.3 Be accountable for the use of digital agency 3.1.4 Enforce ethical use by means of using digital agency 3.1.5 Practice digital agencies
4. Literacy for all dimensions 4.1 Critical Thinking (21 st century skills)	Critical thinking [20, 24, 44, 45]	4.1.1 Use critical thinking skills to develop socially 4.1.2 Use critical thinking skills to develop emotionally 4.1.3 Use critical thinking skills to improve literacy 4.1.4 Use critical thinking skills to become inquisitive 4.1.5 Use critical thinking skills to think clearly and rationally

(*continued*)

Table 1. (*continued*)

Dimensions digital literacy model		
4.2 Creativity (21 st century skills)	Creative development - computational artifacts [45, 46]	4.2.1 Emphasize learner's digital creativity 4.2.2 Using creative development processes to create computational artifacts or to solve problems 4.2.3 Combine technology and creativity skills to express oneself 4.2.4 Encourage learners to use creativity skills to design and develop information 4.2.5 Encourage learners to use information in an ethical manner
4.3 Collaboration (21 st century skills)	ICT to develop a social network and work in a team [30, 45, 47]	4.3.1 Collaboration to work effectively in a team 4.3.2 Collaboration to exchange information 4.3.3 Collaboration to make decisions. 4.3.4 ICT and collaboration to enhance the learning experience 4.3.5 Establishing a collaborative, flexible relationship with other teachers and learners 4.3.6 Collaboration to redesign learning material
4.4 Communication (21 st century skills)	Communication and ICT literacy [30, 33, 45, 48, 49]	4.4.1 Communication skill and ICT to perform any professional activity 4.4.2 Enhance meaningful learning through the practice of good communication skills 4.4.3 Communication skill for social media/Internet 4.4.4 Communication skills to enhance collaboration 4.4.5 Communication skill to compose, view and communicate the ideas to learners 4.4.6 Engage information sharing by means of enforcing good communication skills

(*continued*)

Table 1. (*continued*)

Dimensions digital literacy model		
4.5 Flexibility (21 st century skills)	Flexibility and ICT [14, 50]	4.5.1 Enforcing flexibility to use different learning platforms to obtain progress in online learning 4.5.2 Be flexible in using ICT and subject content to learn from things and people different from oneself
4.6 Leadership (21 st century skills)	Technology literacy and leadership skills [24, 51–53]	4.6.1 Provide leadership in the development of ICT literacy standards/material 4.6.2 Show leadership in stepping forward and acknowledge risks and vulnerabilities 4.6.3 Encourage trust and confidence among the learners by taking leadership 4.6.4 Take leadership and seek to maintain control on more challenging classes 4.6.5 Be a leader in integration ICT in the classroom
4.7 Initiative (21 st century skills)	New initiatives ICT initiatives (Internet Safety Day, Poster for cyber risks) [1, 2, 54, 55]	4.7.1 Creating and implementing initiatives to improve cyber safety culture 4.7.2 Be involved in government initiatives to educate cyber safety 4.7.3 Be involved in school initiatives to educate cyber safety 4.7.4 Be involved in international initiatives to educate cyber safety 4.7.5 Promote literacy initiatives
4.8 Productivity (21 st century skills)	Productivity skills [24, 56]	4.8.1 ICT technology to improve learning productivity 4.8.2 ICT technology to improve learning performance 4.8.3 Be productive to increase the number of learning material

5 Conclusion

Cyber users need cyber safety awareness to guide them against cyber risks and cybercrimes. Research show that many schools lack the equipment and trained educators in computer science. South African schools lack education initiatives and resources regarding cyber safety, and South African schools do not have a cyber safety curriculum. In another study, it was indicated that almost 50% of South African schools do not have a cyber safety policy in place. Out of the above research done by the researchers it is vital to acknowledge that much need to be done to get South African schools and the educators cyber safety aware. Cyber knowledge together with skills will enhance cyber safety awareness. The aim of this research was to determine the knowledge areas and skills that an educator needs to enhance cyber safety awareness of learners (also known as cyber users) within a South African school environment. This research recommends a number of knowledge areas and skills through a proposed theoretical framework that can be used to create and enhance cyber safety awareness.

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Conceptualising a Dynamic Technology Practice in Education Using Argyris and Schön's Theory of Action

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Abstract. Despite substantial national effort to integrate technology in education, it seems that practitioners in the education system are not working in line with the given policy. Evidence from large-scale studies of students' technology practices at school over the last decade show disparities in student practices. The observed gap between the micro and the macro level call for a closer exploration. Research that explores the influence of social and organizational factors may be useful for understanding the processes behind such gaps. Argyris and Schön's 'Theory of Action' (1978) is proposed as an example of an organizational theory that can be adopted in educational technology research to move towards understanding the complexities of technology practice. To encourage discourse and application of Argyris and Schön's theory in the field of educational technology research, this paper introduces the theory, a review of its empirical application in research of teacher educations' technology practice and relevant conceptual work. The paper presents a conceptual framework based on Argyris and Schön's theory that has been developed through two recent studies, and invites its application in future research and development.

Keywords: Theory of action · Digital school · Teacher education · Digital attitude · Digital literacy

1 Introduction

Much work in education is focused on the role of technology to foster skills and competencies that prepare students for their digital futures. Several international studies show that teachers integrate technology insufficiently in their educational practices [24, 29, 30, 32]. ICT has not changed education as much as anticipated by policy-makers. Yet, a growing body of research details disparities in primary and secondary school students' technology practices, skills and knowledge associated with a range of social and cultural factors [18]. Evidence from large-scale studies of developed nations over the last 10 years shows that such disparities have remained more or less constant. Despite an extensive body of educational technology research, there is limited research that provides a detailed understanding of students and teachers' technology practice in the educational context. Much of the empirical research to date has focused on the long-lasting introduction of new technology in schools and society, and the effects of

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 291–300, 2019.
https://doi.org/10.1007/978-3-030-35343-8_31

these various technological artefacts on learning. This work provides important evidence of the effectiveness of using specific technologies to support specific learning processes and outcomes. However, what is missing is a broader understanding of technology practice in education [5, 20, 21]. Research that conceptualises digital technologies as social tools, surrounding the artefact, its use and its context, will help provide an understanding of the interrelations between technology practice, teachers and students. An increasing body of research proposes that a theoretically founded definition of technology and practice may offer a means to extend research agendas beyond effects of technology and the immediate practical consequences [21, 26]. Research in the field of educational technology would benefit from an organizational framing that pays attention to the understandings and attitudes of learners and considers the social and cultural milieu of technology practice [7, 27]. This has motivated calls for a more critical approach to the investigation of technologies for learning that extends beyond short-term advance [26, 27]. The inclusion of these types of studies within the literature can address questions of how individual, physical, social and cultural structures interrelate to shape technology practice.

2 Argyris and Schön's Theory of Action

Their theoretical constructs serve as theoretical and methodological tools for systematic analysis of learning organizations at the meso-level (between macro and micro). Theory of action is a theoretical framework offering an analytical distinction between an individual or an organisations' espoused theory and their theory in use. This theory is based on the notion that "humans have programs in their heads on how to act effectively in any type of situation" [2]. These programs is understood as maps or theories of how we understand the world. Argyris [1] claims that it is impossible to reason anew in every situation, and explains: "If we had to think through all the possible responses everytime someone asked, "how are you?" the world would pass us by".

Therefore, everyone developes a theory of action: "a set of rules that individuals use to design and implement their own behaviour as well as understand the behaviour of others" [1]. The theory of action consists of two different types of theories, "there are important differences between the meanings created when people espouse their views and when they act them out" [1]. Argyris og Schön [3] defines this distinction as the theory in use and the espoused theory. The theory in use is guiding our actions, while the espoused theory is our explanations of why and how we are acting.

2.1 Theory in Use

Insight in peoples theory in use is gained when you observe people's behaviour and try to establish what rules that would make sense of the action. Peoples primary theory in use is referred to as "model 1". This strategy tends to have the purpose "to control unilaterally the relevant environment and tasks and to protect oneself and others unilaterally" [1]. Other underlying strategies are "unilateral control over others. Characteristic ways of implementing this strategy include making unillustrated attributions and evaluations, advocating in ways that discourage inquiry, treating one's own views as obviously correct, making covert attributions and evaluations, and face-saving" [1]. The consequences of these Model 1 strategies are likely to be defensiveness, misunderstanding, and self-fulfilling and self-sealing processes [1]. "Defensive reasoning encourage individuals to keep privat the premises, inferences, and conclusions that shape their behaviour and to avoid testing them in a truly independent, objective fashion" [2]. Such theories in use are learnt early on in life and therefor the actions that they produce are highly skilled. Little conscious attention is needed to produce highly skilled action [1]. Contrary to model 1, Theory in use "model 2" needs conscious attention. Tese theory in use is applied when the governing values are valid information, informed choice, and vigilant monitoring of the implementation of the choice in order to detect and correct error. Model 2 theories are, at the outset, espoused theories. The challenge is according to Argyris [2] "to help individuals transform their espoused theories into theories-in-use by learning a "new" set of values and skills".

2.2 Espoused Theory

An individuals' espoused theory is expressed when a person is asked to articulate which rules are governing the persons action. In other words, the theory "which is advanced to explain or justify a given pattern of activity" [4]. Espoused theory is based on the "principles and precepts that fit our intellectual backgrounds and commitments. But most of us have quite a different theory-in-use to which we resort in moments of stress" [2].

2.3 The Paradoxical Relationship Between Theory in Use and Espoused Theory

Individuals creates meaning and purpose by observing and describing the world in certain ways. But what we espouse and what we do are not always aligned. A paradox in human behaviour is that the theories that are guiding our behaviour rarely are the theories we think we are guided by. This happens both counsciously and more subconsciously, and asking critical question regarding the discrepancy between ones espoused theory and theory in use can be challenging. "Human beings are said to be programmed to act automatically and tacitly in ways that are counterproductive to their espoused theories" [1]. "Put simply, people consistently act inconsistently, unaware of the contradiction between their espoused theory and their theory-in-use, between the way they think they are acting and the way they really act" [1]. Individuals' theory in use is to a great degree similar across gender, age and cultures, while an individuals' espoused theory can vary from individual to individual [2].

2.4 Single-Loop and Double-Loop Learning

In Argyris and Schön's learning theory the link between learning, change and resistance to change is central. It outlines two levels of learning: single-loop learning and double-loop learning (see Fig. 1). Single-loop learning is instrumental learning [4]. It involves following routines and pre-set plans. This is both less risky for the individual and the organisation. Single-loop learning seems to be present when goals, values, frameworks and strategies are taken for granted, with only minor updates [28]. In single-loop learning processes the emphasis is on techniques and to make such more efficient. This level of learning changes strategies of action or assumptions underlying strategies in ways that leave the values of a theory of actions unchanged. Reflections are directed towards making the existing strategy more effective [4]. Double-loop learning, in contrast, are more creative and reflexive. It involves the consideration of notions about what is good. This form of learning results in a change in the values of theory in use, as well as in strategies and assumptions [4]. In double-loop learning processes (1) the basic assumptions behind ideas or policies are challenged and confronted, (2) hypotheses are publicly tested amd (3) processes are challenging, not self-seeking and have organisational goals. Double-loop learning involves questioning the role of the framing and learning systems that underlie actual goals and strategies [1, 3, 4].

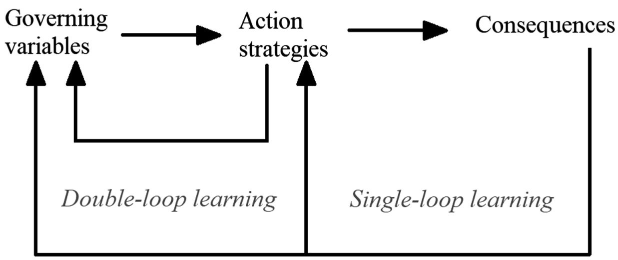

Fig. 1. Single-loop and double-loop learning [2]

3 Argyris and Schön's Theory in Educational Research

The application of Argyris and Schön's theory offers educational research a tool to recognize the differing experiences that contribute to learning.

The studies we included met the following criteria:

1. Published in a peer-reviewed journal.
2. Present empirical research or review. This criterion was applied to ensure claims made in the studies were supported by data and thus exclude pure theoretical work.
3. Examines educational practice or contexts for learning. Argyris and Schon's theory is particularly useful in understanding the structures and relations that shape practice across diverse backgrounds and contexts.
4. Used Argyris and Schön's constructs to conceptualise theory in use and espoused theory (not applicable for review articles).

The searches were conducted in ERIC - Education Resources Information Center and ISI Web of Science. In ERIC the search was "Argyris", with the filter "peer reviewed only". This resulted in 65 articles. Descriptors also used when searching was (1) Theory Practice Relationship and (2) Educational practices (Table 1).

Table 1. Articles included in the review.

Article	1	2	3	4
Madsen, Thorvaldsen and Archard [15]	Yes	Survey including 108 teacher educators	Yes	Yes
Madsen, Thorvaldsen and Archard [16]	Yes	Survey including 108 teacher educators, and in-depth interviews with 20 teacher educators	Yes	Yes
Thorvaldsen and Madsen [28]	Yes	Survey including 67 teacher educators and 48 teacher students	Yes	Yes
Bulkley and McCotter [6]	Yes	Case study involving 3 prospective elementary and middle school leaders. Data collection for this study included a combination of interviews, observations, and document analysis	Yes	Yes
Sandvold [25]	Yes	Data from observing two seminar groups and from interviewing teachers and students. Using Argyris' theories of action as a theoretical framework, the study explores the relationship between realities of practice and espoused theories	Yes	Yes
Perger [22]	Yes	Test results, survey and observation of three underachieving students	Yes	Yes
Loizou [12]	Yes	Semi-structured interviews with a cross section of 18 Cypriot primary school teachers	Yes	Yes
Mellati, Fatemi and Motallebzadeh [17]	Yes	The study investigates the relationship between Iranian English Language Teaching instructors' beliefs about language teaching and their real practices in classrooms. To collect data questionnaires and semi-structured interviews were employed	Yes	Yes
Kerr [10]	Yes	Comparative analysis of conceptions and tools of practice of information literacy in 11 academic libraries in the US	Yes	Yes
Leonard [11]	Yes	Analysis of 33 mentor teachers' professional experience reports	Yes	Yes
Houchens, Hurt, Stobaugh and Keedy [9]	Yes	A qualitative case study that examines the extent to which a coaching protocol based on theories of practice enhanced principals' self-perceived capacity for reflection and effective instructional leadership	Yes	Yes
Robey, Boudreau, Rose [23]	Yes	This paper reviews and assesses research literature on information technology and organizational learning	Yes	N/A
Estes [8]	Yes	A questionnaire completed by 76 participants and 44 staff in adult standard courses held at the North Carolina and Colorado Outward Bound schools	Yes	Yes

The ISI Web of Science search was made by using the topic "Argyris", and refining the search by the Web of Science categories: (1) education educational research, (2) computer science interdisciplinary applications or (3) education scientific disciplines. This resulted in additional 35 articles. A selection of relevant articles based on the presented four criterions for this review, is listed below.

4 Conceptualising Processes Towards Technology Practice Using Argyris and Schön's Theory

Drawing on review of the above empirical studies and relevant conceptual work, the following conceptualization of development of technology practices in educational settings was developed and refined through a PhD [14]: A questionnaire based on Argyris and Schön's theory involves three main constructs: Professional Digital Competence, Professional Attitude and Professional Applications of Tools. To gain insight into the respondents' theories in use, the questionnaire contains questions regarding the extent of use of different digital technologies. Professional digital competence is operationalised by using definitions by Tømte and Olsen [31] and Lund, Furberg, Bakken and Engelien [13]. In accordance with the definition, three defined aspects of digital competence is structuring the statements in the questionnaire: pedagogic and didactic understanding, subject-specific understanding and technological understanding. This definition of digital competence is generally in agreement with resent literature, regarding its categorical understanding of digital competence. To illuminate attitudes (espoused theories), statements were prepared based on the OECD report 'Connected Minds: Technology and Today's Learners' [19] and its description of the field's existing attitudes towards technology. In the report, the field is described as characterized by stretching from being technology averse to technology positive. Statements are prepared to identify the respondents' own motivations for using digital tools, the respondents' attitudes towards digital tools' position in the public arena and attitudes towards the use of digital tools in educational settings. Some items had a reversed scale, denoted by REV. The constructs were each based on questionnaire items, as follows:

4.1 Professional Digital Competence (PDC)

- I am familiar with digital tools that can help diversify teaching.
- I am, in general, confident when using digital tools.
- I find it easy to become familiar with new digital tools.
- I can use digital tools that are appropriate for the aspects of the subjects I am teaching.
- It is difficult to use digital tools as an educational resource within my subject. REV.
- When I am using digital tools it is difficult to adjust the content to the individual students' needs. REV.
- I have no clear idea of learning outcome when using digital tools in my teaching. REV.
- I use digital tools when giving feedback to students.

4.2 Professional Attitude

- When I use digital tools in my teaching, I find it adds value.
- The use of digital tools is essential for good teaching.
- Society's expectations for the impact of digital tools are exaggerated. REV.
- Expectations related to the use of digital tools in education frustrate me. REV.
- In professional debates at our organization, the expectations of the impact of digital tools are exaggerated. REV.
- The use of digital tools is disruptive for the relationship between student and teacher. REV.
- Digital tools can make the students more interested in the subject I am teaching.
- I like testing new digital tools in my teaching.

4.3 Professional Application of Tools

- Digital tools for testing with multiple choice questions
- Moodle or Fronter (each university's learning management system)
- Digital tools for presentation (like PowerPoint or Prezi)
- Word processor
- Spreadsheets (like Excel)
- Use of video
- Production of film/video/animation
- Online discussions
- Online meetings (like Lync, Adobe Connect or Skype)
- Production of Wiki (website that allows collaborative modification)
- Screen capture (like Camtasia or Mediasite)
- Programs for scientific analyses
- Student response systems (online questions answered by phone or computers, like Kahoot! or Socrative)
- Tools for collaborative writing (like Google Docs)
- Social media (like Facebook or Twitter)
- The Internet as a source of knowledge

Argyris and Schön's theory were born out of empirical research, and thus were intended to be methodological tools with which to study social and organizational phenomena.

Robey et al. [23] writes that one emerging stream of empirical work uses organizational learning to understand the implementation and use of information technology in organizations. They claim that driving this inquiry is the realization that information technology frequently yields disappointing results, as low payoffs, financial losses, dissatisfied users, and no increase in organizational effectiveness. Robey et al. [23] further explains that a second emerging stream of research on information technology and organizational learning seeks to guide the application of technologies that support organizational learning. It is clearly valuable to examine both the consequences of learning and the processes that produce those consequences, and definitions of organisational learning tend to emphasize either one or the other. The reciprocal relationship between the two research streams illustrated in Fig. 2.

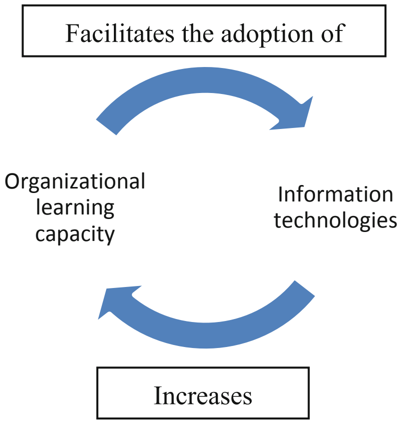

Fig. 2. Relationship between the two research streams [23].

Our survey is focusing on the implementation and use of digital technology. One should also investigate how this method can be further developed to better utilize the connection between the two theoretical streams described by Robey et al. [23].

5 Conclusion

In this paper, we have reviewed the empirical research of 13 studies using Argyris and Schön's Theory of Action to investigate educational practice. These studies have contributed to the field of educational research by highlighting how Argyris' theoretical framework can be used to study theory in use and espoused theory to understand practices. The questionnaire developed with a focus on digital technology in education builds on the notion that technologies are organizational tools, and that practices are complex and influenced by a broad range of social and cultural factors. The issues raised in these paper present challenges for educational technology researchers in understanding the complex landscape and adopting a process based methodology. The application of Argyris and Schön's constructs offers a fresh approach to investigating technology practice within educational design and development by providing a joint conceptual methodology.

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An Innovative BERT-Based Readability Model

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Abstract. Readability is referred to as the degree of difficulty to which an given text (article) can be understood by readers. When readers are reading a text with high readability, they will achieve better comprehension and learning retention. However, it has been a long-standing critical challenge to develop effective readability prediction models that can automatically and accurately assess the readability of a given text. When building readability prediction models for the Chinese language, word segmentation ambiguity is often a knotty problem that will inevitably happen in the pre-processing of texts. In view of this, we present in this paper a novel readability prediction approach for the Chinese language, building on a recently proposed, so-called Bidirectional Encoder Representation from Transformers (BERT) model that can capture both syntactic and semantic information of a text directly from its character-level representation. With the BERT-based readability prediction model that takes consecutive character-level representations as its input, we effectively assess the readability of a given text without the need of performing error-prone word segmentation. We empirically evaluate the performance of our BERT-based readability prediction model on a benchmark task, by comparing it with a strong baseline that utilizes a celebrated classification model (named fastText) in conjunction with word-level presentations. The results demonstrate that the BERT-based model with character-level representations can perform on par with the fastText-based model with word-level representations, yielding the accuracy of 78.45% on average. This finding also offers the promise of conducting readability assessment of a text in Chinese directly based on character-level representations.

Keywords: Readability · Representation learning · BERT · fastText · Text classification

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 301–308, 2019.
https://doi.org/10.1007/978-3-030-35343-8_32

1 Introduction

The scientific studies of the Chinese language has grown rapidly for decades [1–7]. For example, text readability assessment is an important application in language acquisition field. In general, the readability of a text is used to assess the degree to which it can be understood by its readers [8, 9]. When a text with high readability is read by a reader, it is expected that he or she will achieve better comprehension and learning retention [9]. However, there are many factors that have impacts on text readability, such as text legibility (e.g., layout), lexico-semantic (e.g., rare, unfamiliar or ambiguous words), morphological (e.g., rare or more complex morphological particles), syntax (e.g., grammatical structure), discourse (e.g., Cohesive text), advanced semantics (e.g., domain or world knowledge required to comprehend a text) and pragmatic (e.g., contextual or subjective language influenced by genre), to name just a few [10]. In the past, researchers have already extensively studied the influences of the aforementioned factors on text readability from different perspectives. For example, Gyllstrom and Moens (2010) proposed an AgeRank algorithm; they used the information about the page color and the font size to help determine the readability of Web pages (documents) [11]. Furthermore, Fourney, Morris, Ali and Vonessen (2018) used 14 features of pages (e.g., mean_text_contrast; mean_font_size; mean_line_length) to explore the readability features that have to do with the differences in readability/relevance judgments observed between dyslexic and non-dyslexic populations [12]. Yet, it is still a research-worthy topic that many scholars and practitioners either focus on developing new linguistic features [13–17], or improving on state-of-the-art readability models [18, 19].

However, the inability of common general linguistic features (i.e., a set of lexical, syntactic, semantic, and cohesion-related features) to reflect the difficulty level of the knowledge contained in domain specific texts remains a crucial problem [20]. As pointed out by Redish (2000), when a domain-specific term appearing in a domain-specific text is also a commonly-used word, which means the term's difficulty level within that text cannot be accurately represented using general linguistic features [21]. Moreover, in analyzing the US medical database, Medical Subject Headings (MeSH), Yan, Song and Li (2006) found that the number of syllables and the word length of a medical term were not related to the term's level of difficulty [22]. They used the medical symbols hierarchical database as their concepts database, determined the concepts in each of the medical texts in MeSH, and then calculated the distance of each concept to the root of the tree structure to obtain the document scope. Their study compared how well the readers' level of understanding was predicted by using the document scope and other traditional formulas, with the associated results indicated that document scope is a good predictor of the readability of medical texts. In view of the inability of general linguistic features employed by traditional readability formulas to measure the knowledge of domain specific texts, how to reasonably and effectively overcome this shortcoming becomes a topic worthy of further research.

The other issue in building a Chinese readability model is word segmentation. In conventional Chinese readability models, word segmentation is one of the most basic and important procedures in the pre-processing of texts. However, the ambiguity arising from word segmentation is often a knotty problem that will inevitably happen in the pre-processing of texts. In the light of above discussions, we present in this paper a novel readability prediction approach for the Chinese language, building on a so-called Bidirectional Encoder representation from Transformers (BERT) [23] model recently proposed by Google, which can capture both syntactic and semantic information of a text directly from its character-level representations. The rest of this paper is organized as follows. Section 2 reviews two representation learning algorithms: one is BERT and the other is fastText. Section 3 will evaluate the performance of the readability models respectively stemming from the two learning algorithms introduced in Sect. 2. In the final section, we conclude the paper alongside further avenues of future research.

2 Distributed Representation Learning Algorithms

Representation learning, i.e., learning representations of the data that make it easier to extract useful information cues or features for building a statistical model for a certain application [24]. For example, it is anticipated that leaning suitable representations for data instances of interest can enhance the efficiency and effectiveness of a statistical model to perform classification on them. This study will explore the use of disparate representation learning algorithms to derive semantic embeddings (vector representations) as the readability features for building a more generalized readability model. To this end, we develop a novel readability model based on BERT [23] and evaluate its performance level by comparison to a strong baseline based on the fastText learning algorithm, which was previously proposed in [25].

2.1 fastText

Ever since the advent of Word2vec [26], a powerful algorithm for deriving vector representations of words, Joulin et al. (2016) presented a continued effort to improve the structure of Word2vec and develop a prominent of it named fastText. The associated training algorithm of fastText is very similar to one variant of Word2vec (i.e., CBOW) with the key distinction that fastText changes the prediction of the current word to the prediction of the corresponding classification label of the text span (in terms of *n*-gram) that surrounds the current word.

2.2 BERT

BERT is a novel neural language model which makes effective use of bi-directional self-attention (also called the Transformer) to capture both short- and long-span contextual interaction between the tokens in the input sequence, usually in the form of words or word pieces. The training of BERT consists of two stages: pre-training and fine-tuning. At the pre-training stage, its model parameters can be estimated on a huge volume of unlabeled training data over different tasks such as the masked language model task and the next (relevant) sentence prediction task. At the fine-tuning stage, the pre-trained BERT model can be fine-tuned with only one additional output layer to generate top-performing task-specific models on many NLP-related tasks if the associated labeled training dataset is provided.

3 Experiments

3.1 Experimental Dataset

The experimental dataset for this study were adopted from the one to twelfth grade textbooks published in 2009 by three major publishers in Taiwan, namely, Nan [27], Lin [28], and Hsuan [29]. The dataset consists of 2,382 social science articles, 1,633 natural science articles and 633 Chinese literacy articles, which amounts to a total of 4,648 articles (texts). Each article was an independent lesson from one of these textbooks. Further, for each article, in addition to the main text content, it also contains a heading, a descriptive text and punctuation marks, as well as the captions of tables and figures. Homework exercises, guided learning questions, and extracurricular content were not considered here. For the experiments reported below, we randomly selected 3,720 articles as the training data, and the rest of 928 articles as the test data for measuring the efficacy of the readability prediction models.

3.2 Training of Readability Models

As mentioned above, with the BERT-based readability prediction model, we can effectively assess the readability level of a given text without the need of performing error-prone word segmentation. To empirically evaluate the performance of our BERT-based readability prediction model on a benchmark task, we also implemented a strong baseline that utilized a celebrated classification model (named fastText) in conjunction with word-level presentations. In this paper, we adopted WECAn [17] to perform parsing of Chinese texts to facilitate the subsequent experimental procedure for training fastText-based readability prediction model. The Dropout [30] was used to avoid overfitting in training neural networks. In addition, rectified linear units (ReLU) [31] was also adopted as the active functions to avoid vanishing gradients.

3.3 Experimental Results and Discussion

The associated results of the BERT-based readability prediction model and the fastText-based one are shown in Table 1. In addition to accuracy results, the adjacent accuracy results obtained by allowing plus/minus one level error in the accuracy calculation are also listed for reference. These results reflect the performance of these two models in predicting the three field textbooks (Chinese literacy, science studies and natural science) for grades 1 to12 (4,648 texts). The accuracy rates for using BERT and fastText are 78.45% and 78.66%, respectively, while the adjacent accuracy rates for using BERT and fastText are, by coincidence, the same, namely 90.95%. These preliminary results demonstrate that the BERT-based model with character-level representations can perform on par with the fastText-based model with word-level representations. This finding also offers the promise of conducting text readability assessment of the Chinese language directly based on character-level representations.

Table 1. The performance of various readability models.

		Accuracy	Adjacent accuracy
Model 1	fastText	78.45%	90.95%
Model 2	BERT	78.66%	90.95%
Model 3	Common-linguistic-features	38.90%	69.94%

Apart from the fastText-based readability model, we also compare the BERT-based model with a traditional readability model that exploits a set of handcrafted linguistic features. This model takes 15 general linguistic features developed by Sung et al. [15] as its input, including four levels of features, namely, the lexical, semantic, syntactic, and cohesion levels, and is configured with a feedforward neural network with three hidden layers. As can be seen from Table 1, the representation learning based readability models, viz. fastText and BERT, has better domain generalization ability than the conventional model with a set of handcrafted linguistic features. As an aside, Tables 2, 3 and 4 show the confusion matrix for each of the readability models compared in this paper.

Table 2. The confusion matrix of fastText-based readability model.

Model 1		Predicted grade level												Grade accuracy
		1	2	3	4	5	6	7	8	9	10	11	12	
Actual grade level	1	4	1	0	0	0	0	0	0	0	0	0	0	80.00%
	2	0	10	0	0	0	0	0	0	0	0	0	0	100.00%
	3	0	2	28	4	3	1	0	1	0	0	0	0	71.79%
	4	0	2	3	24	3	4	0	1	0	0	0	0	64.86%
	5	0	0	1	3	32	10	2	1	0	1	0	0	64.00%
	6	0	0	2	0	4	30	2	2	2	2	0	0	68.18%
	7	0	0	0	0	1	3	87	0	0	2	0	0	93.55%
	8	0	0	0	0	0	1	5	121	3	4	0	0	90.30%
	9	0	0	0	0	0	1	2	1	84	6	1	0	88.42%
	10	0	0	0	0	0	3	9	6	2	88	14	5	69.29%
	11	0	0	0	0	0	0	3	2	2	18	127	11	77.91%
	12	0	0	0	0	1	0	3	0	0	13	21	93	70.99%

Table 3. The confusion matrix of BERT-based readability model

Model 2		Predicted grade level												Grade accuracy
		1	2	3	4	5	6	7	8	9	10	11	12	
Actual grade level	1	3	2	0	0	0	0	0	0	0	0	0	0	60.00%
	2	1	7	2	0	0	0	0	0	0	0	0	0	70.00%
	3	0	2	25	6	6	0	0	0	0	0	0	0	64.10%
	4	0	1	2	25	4	3	1	1	0	0	0	0	67.57%
	5	0	0	0	5	35	9	0	1	0	0	0	0	70.00%
	6	0	0	2	0	9	23	0	3	6	1	0	0	52.27%
	7	0	0	0	0	4	3	77	3	5	1	0	0	82.80%
	8	0	0	0	0	1	0	0	124	4	4	0	1	92.54%
	9	0	0	0	0	0	0	1	2	88	3	0	1	92.63%
	10	0	0	0	1	2	0	2	3	4	91	12	12	71.65%
	11	0	0	0	0	0	0	0	2	4	16	131	10	80.37%
	12	0	0	0	0	1	0	1	1	0	12	15	101	77.10%

Table 4. The confusion matrix of common-linguistic-features-based readability model

Model 3		Predicted grade level												Grade accuracy
		1	2	3	4	5	6	7	8	9	10	11	12	
Actual grade level	1	0	4	1	0	0	0	0	0	0	0	0	0	0.00%
	2	0	8	2	0	0	0	0	0	0	0	0	0	80.00%
	3	0	4	17	7	0	3	2	3	2	0	1	0	43.59%
	4	0	3	7	7	3	6	7	3	1	0	0	0	18.92%
	5	0	0	2	7	14	9	9	1	5	3	0	0	28.00%
	6	0	0	4	4	3	20	2	4	2	5	0	0	45.45%
	7	0	0	7	1	3	5	25	28	8	9	2	5	26.88%
	8	0	0	0	0	1	0	29	58	18	10	10	8	43.28%
	9	0	0	0	2	1	1	19	22	22	11	10	7	23.16%
	10	0	1	0	2	1	3	11	7	5	59	21	17	46.46%
	11	0	0	0	0	1	0	10	3	4	37	73	35	44.79%
	12	0	0	0	0	1	1	4	3	5	30	29	58	44.27%

4 Conclusion and Outlook

This study have explored two appealing representation learning algorithms for automatically extracting readability features, as described in Sect. 2. The empirically results have also shown that the readability prediction models building on them are capable of determining text readability, as discussed in Sect. 3. Especially, the BERT-based prediction model indeed offers the promise of conducting text readability assessment of the Chinese language directly based on character-level representations. As to future work, we plan to apply different automatic summarization techniques to text readability analysis.

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Framework for Knowledge Asset Management in Community Projects in Higher Education Institutions

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Abstract. Innovation in education encourages stakeholders to explore and apply different ways of looking at problems and solving them. Large-scale community projects (LSCPs) in a higher education institution (HEI), provide an ideal environment for combining curriculum outcomes, education innovation, real-world engagement and knowledge assets. However, current research that focuses on knowledge asset management in innovative learning is limited, and this study aims to contribute a holistic approach for managing knowledge assets in this context. In this study, we designed a knowledge asset management framework for LSCPs in higher education taking cognisance of innovative educational model characteristics. We applied the framework by mapping it to a community project module from an HEI using the elements of the framework as a guide. By using the knowledge asset management framework for LSCPs in higher education, an HEI can ensure that their community module enables strong support to the community, that students' knowledge and skills are enhanced and that all new knowledge assets created during the project delivery, are captured and stored using innovative technology sets.

Keywords: Knowledge asset management · Innovative education · Knowledge exchange · Community projects

1 Introduction

The delivery of high quality, efficient and innovative education in increasingly complex systems, is a key requirement [1]. Furthermore, the development of innovative technologies also contribute to the increasing complexity, emphasising the requirement to focus on more than own knowledge. Focus should also be on; adapting to organisational requirements, to operate and manage information, to make decisions and to learn lifelong [1, 2]. Innovative learning may be achieved through pedagogical innovation (change teaching style), scientific and methodological innovation (introduce innovative course content), and education and technological innovation (application of improved learning technologies) [1].

Education which connects the student's real life and prior knowledge, has the potential to create meaningful learning environments in which they could develop their creativity, problem solving and innovation skills [3]. One opportunity that combines a focus on curriculum outcomes, knowledge assets, real-world engagement and learning,

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 309–319, 2019.
https://doi.org/10.1007/978-3-030-35343-8_33

is HEI facilitated community-based projects [4]. Community-based projects are regarded as a high-impact practice that improves student engagement, pointing to interaction and commitment among the community project parties [5]. LSCPs combine academic study with community service by having students voluntarily become part of community projects, focusing on achieving academic goals for students and fostering meaningful, beneficial outcomes for communities [2, 6].

However, scholars identified several problems with regard to academic learning programmes in LSCPs. Problems include the transfer of homogenous, university-based knowledge only, a lack of academic development measurement, a low adoption of deeper learning approaches such as project-based learning activities, poor knowledge asset management and limited examination of the impact of reflection in community based programmes [2, 6–8]. In addition, Bedford [4] presents several challenges that universities encounter when establishing and managing knowledge assets in an academic program.

This study aims to contribute to innovation in education by considering a novel approach to managing knowledge throughout the community project execution [9, 10]. It also aims to investigate the knowledge asset management mechanism that inform knowledge-based flows in a community module, optimising outputs and fostering innovation. Therefore, the primary research question that this study aims to address is: "*How can knowledge assets created in a large-scale community project in an HEI be managed innovatively*?". The aim of such a framework is to outline the guiding principles and key structural elements required to manage knowledge assets created during LSCPs contributing to all aspects of innovative learning [1]. Such knowledge assets also provide a platform for continuous value add and knowledge transfer from community project to project in the context of a community partner as a new project team may build on, and enhance, previous community project work.

Section 2 of this paper provides the background to the study and presents the role players, engagement and knowledge transfer play as part of community learning. The approach to this study is discussed in Sect. 3, while Sect. 4 provides an overview of the knowledge asset management framework. Section 5 maps a community-based academic module to the knowledge asset management framework to establish the proposed framework's suitability as an innovative tool. Section 6 discusses the findings and concludes the paper.

2 Background

The main aspects of innovative development in HEIs include; staff development, social development, educational process development, economic development, technological development and organisational development [11]. Furthermore, educational innovation is purpose-orientated and includes system, process or implementation methods that are significantly different from established practices [1, 11]. Learning in community-based projects is defined as "an educational methodology that combines community-based experiences with explicit academic learning objectives and deliberate reflection" [12]. The success of community learning modules in HEIs depends on multiple factors and inter-relationships, including the HEI context, the student group involved, the community involved, existing knowledge assets and the desired learning outcomes [12–14]. It is also recognised that community engagement is a complex, multi-faceted process that involves relationships in, for and with communities [3, 14].

In the following sections, characteristics of innovative educational models, LSCPs in HEIs and knowledge asset management in the context of community projects, are considered.

2.1 Characteristics of Innovative Educational Models

In the world of education, innovation comes in many forms and encourages lecturers and students to explore and use different tools to uncover new approaches. It involves a different way of looking at problems and solving them [15]. Characteristics of innovative educational models include multiple aspects. *Context* points to combining educational, scientific and practical aspects of student activities into real-world scenarios. *Imitation* refers to the application of games and simulation in learning, while *modular* includes structuring educational material content to maximise mastering. Students are encouraged to conduct independent knowledge searches through *problematization* of learning material where differentiated tasks encourage students to apply different abilities to acquire knowledge [1, 11, 15].

Community projects in an HEI aim to increase knowledge, while providing a service to the wider community from a holistic perspective [16, 17]. The role of an HEI in this instance includes the development of cross-boundary knowledge and requires new approaches to knowledge generation and transmission as students must be able to apply knowledge in- and outside academic structures [18, 19].

In this section, we reflected on educational innovation and the role of community based projects. Hence, the next section presents the considerations related to knowledge conversion in the context of LSCPs in an HEI.

2.2 Knowledge Asset Management

Knowledge can be categorised as either explicit (has been expressed) or implicit (deeply embedded knowledge that is less tangible) [20, 21]. Tacit knowledge, as a dimension of implicit knowledge, is personal and context-specific, and therefore hard to articulate and formalise [21–23]. In order to act on information, students need to internalise the information and achieve this by progressing through knowledge conversion processes namely socialisation, externalisation, combination or internalisation. *Socialisation* ensures that knowledge is acquired, after which *externalisation* enables students to express their tacit knowledge (mental models and know-how) [24, 25]. *Combination* is the process of integrating concepts, while *internalisation* is closely related to learning-by-doing, or experiential learning. This process of knowledge conversion ensures that knowledge is advanced through practice, imitation, observation and guidance [19, 24, 26]. Consequently, community based module design should include clearly delineated processes of knowledge conversion, reflection and evaluation, and the management of knowledge assets [5, 27].

The approach of this paper is based on the notion of ensuring that equal focus is given to the knowledge assets that are created during the interaction, as well as learning innovation characteristic alignment. Before the framework for knowledge asset management for LSCPs in an HEI is presented, the research approach is discussed in the next section.

3 Research Approach

The objective of this paper was to establish a framework for innovatively managing knowledge assets created in a large-scale community project in an HEI. We followed an educational design research approach that can be defined as "a genre of research in which the iterative development of solutions to practical and complex educational problems also provides the context for empirical investigation, which yields theoretical understanding that can inform the work of others" [28: 7]. Educational design research is predominantly concerned with developing practical knowledge that aims to improve educational practices [28, 29]. Educational design research yields theories and practical educational interventions as its outcomes [30] and covers five characteristics [29]: theoretically orientated, interventionist, collaborative, responsively grounded and iterative [28]. *Theoretically orientated* refers to the application of scientific understanding to frame the research and shape the design of a solution to a real problem. The *interventionist* nature of educational design research strives to positively affect practice, bringing about transformation through the design and use of solutions to real problems. Educational design research requires *collaboration* among a range of role players who are connected to the problem being addressed. It also requires *responsively grounded* points to participant expertise, literature and field testing of the outcomes of educational design research that is structured to discover and explore the complex realities of teaching and learning contexts, and respond accordingly. The insights and interventions of educational design research evolve over time through multiple *iterations* of investigation, development, testing and refinement, illustrating the iterative nature of the approach [28].

The study was conducted at an HEI in South Africa that offers a compulsory undergraduate community-based project module. In order to evaluate the knowledge asset management framework for HEIs designed from the literature, the proposed framework was mapped to the large-scale community module, corroborating the comprehensive nature of the framework elements.

In the next section, the design of the knowledge asset management framework for LSCPs in HEIs is discussed in detail.

4 Framework for Knowledge Asset Management in Large-Scale Community Projects

The purpose of this study is to present a knowledge asset management framework for LSCPs in an HEI by considering the characteristics of innovative educational models. Three role players are important in the context of an HEI as shown in Fig. 1: the faculty and the lecturer of the community module, the student, and the community partners [14]. From a faculty and lecturer perspective, these roles include the definition of the learning outcomes for the community module, the number of credits allocated to the module and the structuring of the community learning interaction [14, 31]. The *student* needs to complete the community learning module as part of their degree and learn new skills and competencies. The *community partner* provides service opportunities, mentorship and enables active participation with community life. In addition, each of these role-players have their own knowledge assets [14, 32]. From a *faculty perspective*, the *lecturer* has particular knowledge assets around the module design, the learning outcomes, community partner engagement, teaching and learning, etc. *Community partners* hold knowledge about their community, service requirements, skills required, etc. A *student* enters the community-based module with existing knowledge that is reframed into a new understanding and -knowledge through experiential learning enriched by the knowledge exchange from the lecturer and community partners [5, 13].

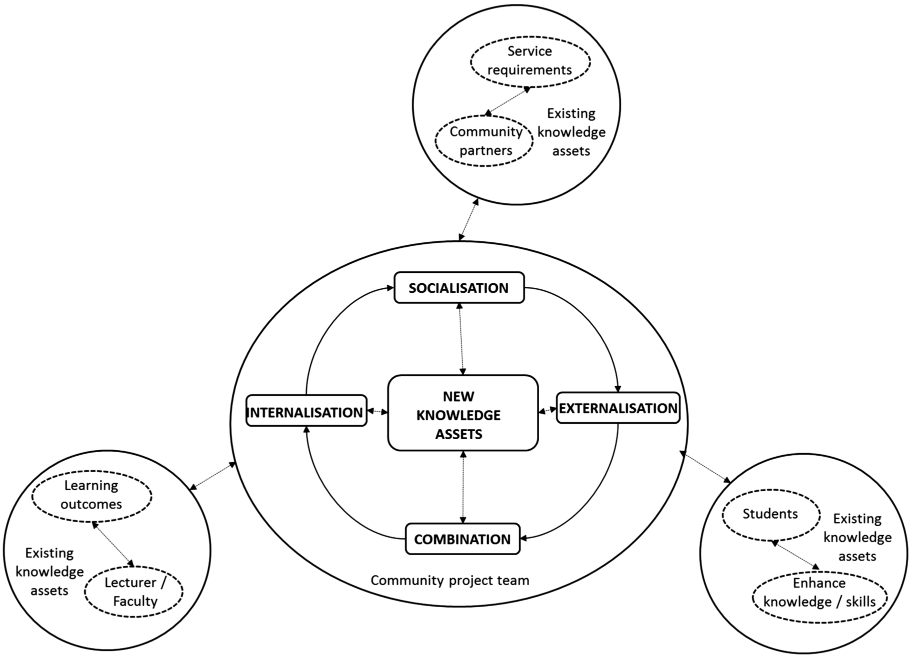

Fig. 1. A knowledge asset management framework for large-scale community projects in HEIs.

In a community-based project, a project team is established with each of these role-players forming part of the team (centre of Fig. 1). Among these role-players, knowledge conversion takes place: between the lecturer, who is focused on the module's learning outcomes, and the student, the knowledge conversion process of *internalisation* is relevant [24]. The student enters the community project with prior knowledge and knowledge about the programme is shared with the student. The *internalisation* knowledge conversion process ensures the extraction of knowledge from the community project module and enables the subsequent filtering of knowledge, ensuring greater relevance and appropriateness of knowledge to the student. At this stage, the enhanced knowledge is theory-based [33]. With this theory, the student embarks on a community project, where the theoretical knowledge is converted to capability through the *socialisation* knowledge conversion process [24]. *Socialisation* is enabled through the experiential nature of the community project and exposure to a real-world problem setting. Once the student has completed the community learning process and ultimately the community module, the *externalisation* knowledge conversion process enables the student to reflect on the learning that took place [24]. *Combination* assists the student in creating new explicit knowledge based on the experience [24].

In the centre of Fig. 1 and as part of new knowledge created by the community-based project team through a knowledge conversion process socialisation, externalisation, combination and internalisation, new knowledge assets are created that must be assimilated, recorded, and stored. This new knowledge must also be made available to new project teams that may enhance or complete work started by a previous project team. Storing of the new knowledge assets create a knowledge repository for community project teams to learn from, potentially shortening the kick off phase of a community project as enhanced prior learning is achieved.

Each knowledge conversion process is also associated with new knowledge assets denoted by an arrow in Fig. 1 New knowledge may be created by one of the knowledge conversion processes as progressing through all four processes is not a requirement to create new knowledge assets. Arrows between the role players and the knowledge conversion process taking place during the implementation of the community project, indicate that each role player interact with the entire system of knowledge asset creation during the execution of the community project.

In order to learn from practice, as guided by our research approach, we proceeded to map a community-based module at an HEI in South Africa to the proposed framework. The mapping and implications are discussed in detail in the next section.

5 Mapping of Knowledge Assets in a Large Scale Community Project

An HEI in South Africa presents a compulsory free-standing undergraduate module: Joint Community-based Project (JCP). The decision to create the independent course was motivated by the need to integrate community service and learning projects, including humanitarian engineering projects, in the curriculum of all the undergraduate programmes in the particular Faculty in addition to adhering to the University's strategic social responsibility goal [34]. The module's primary objectives include benefit realisation for a relevant section of society by exposing groups of students to real-life challenges. Students do at least 40 h of fieldwork, after which they reflect on their experiences through various assignments, including a final presentation, video and report.

It is a macro community engagement course due to the substantial number of enrolled students and projects. Since 2011, more than 1 600 students have registered for the course annually, with an average completion rate of 95%. Generally, the students work in 500 groups each year to help more than 370 different community partners. Implementing this large number of projects successfully requires a unique teaching and assessment model, sustainable community partnerships, robust logistical and financial processes, effective communication and passionate administrative and academic staff.

In order to evaluate the proposed knowledge asset management framework for LSCPs, we considered the individual components of the proposed framework, and the scope and outcome achieved from the class of 2018. In 2018, students enrolled from three different schools at the HEI: some 979 students came from the School of Engineering (10 different degrees), 299 from the School of Information Technology (9 different degrees) and 288 from the School for the Built Environment (6 different degrees), yielding a total of 1566 students. Community projects in 2018 included 235 community partners and 411 projects were completed. Students worked on projects in 5 countries in 2018 and fundamental aspects, including how to identify a project, the steps to complete the project and the assignments that need to be done to complete the module successfully, were included. A small budget of ZAR400 was awarded per student and students were allowed to raise additional funds that are required to complete their project.

We analysed the 411 community project artefacts (project reports, community partner evaluation, YouTube videos, and wikis). Table 1 presents the project types where most projects (24%) were completed for secondary schools, 19% of projects for non-government organisations and 14% for pre-schools. Table 2 depicts the reported knowledge and skills increase where teamwork was indicated the highest at 15%, project management at 12% and communication and interpersonal skills at 12%. Each student could report more than one knowledge and/or skill.

Table 1. Project types, number and %.

Project types	*N*	Percent
Other	3	1%
Government	5	1%
Museum	6	1%
Old age home	8	2%
Learners with special educational needs school	35	10%
Children's home	38	8%
Animal sanctuary & zoo	39	9%
Primary school	47	11%
Preschool	56	14%
NGO	77	19%
Secondary school	97	24%
Total	411	100%

Table 2. Reported knowledge & skills increase, number and %

Skills acquired	*N*	Percent
Other	84	2%
Internet skills	100	3%
Computer skills	144	5%
Diversity	290	9%
Building & renovation skills	314	10%
Creative thinking	316	10%
Leadership	319	10%
Time management	357	11%
Communication & interpersonal skills	382	12%
Project management	398	13%
Teamwork	472	15%
Total	3176	100%

A second output from the analysis of the reports, was to create the mapping produced in Table 3. Table 3 presents an overview of the elements of our proposed framework and for each framework element, we mapped the JCP programme in terms of knowledge assets. We also present how the particular existing and new knowledge assets are captured in order to retain it and make it available for future projects. We could identify clear examples from the JCP module that confirm the relationships that are defined in the framework.

Table 3. Community module mapping to the knowledge asset management framework for large-scale community projects in HEIs

Framework component	Typical knowledge assets	Knowledge asset management mechanism
Students	• Existing, context specific knowledge • Technical related knowledge pertaining to academic degree	• Project selection document • Project motivation document
Faculty or lecturer	• Institutional knowledge • Module and learning outcomes knowledge	• Study guide • Face-to-face briefing • Project guideline document • Security guideline document • Learner management system (LMS) portal
Community partners	• Community knowledge • Service requirement specification • Context-specific know-how	• Mentorship • Technical guidance • Project outcome measurement

(*continued*)

Table 3. (*continued*)

Framework component	Typical knowledge assets	Knowledge asset management mechanism
Community project team	• Project requirement specification • Project management meetings • Community partner briefing • Community partner quality management • Generate new knowledge asset through experience	• Brainstorming • Project meetings • Budget management report • Project report • Reflection report • Youtube video • Facebook page • Wiki • Lessons learnt report on LMS • Community partner project evaluation

Based on this evaluation of the knowledge asset management framework for LSCPs in an HEI, we believe that the framework provides good coverage of considerations for managing knowledge assets innovatively. In addition, Table 3 presents examples of the application of the proposed knowledge asset management framework that may be referenced for module design in order to ensure that new knowledge assets are captured. Such a knowledge asset management process fosters innovation as the application of knowledge to tasks we already know how to do, results in productivity, while applying knowledge to tasks that are new and different, fosters innovation [35].

6 Conclusion

Scholars acknowledge the impact of innovative technologies on learning environments. Therefore, it is a requirement to outline the guiding principles and key structural elements required to manage learning environment knowledge assets contributing to all aspects of innovative learning.

In this study, we designed a knowledge asset management framework for LSCPs in higher education by considering all role players, their knowledge exchange, new knowledge assets generated and the characteristics of innovative educational models. We applied the framework by mapping it to an LSCP module from an HEI using the elements of the framework as a guide. We established that the LSCP module that was mapped conformed well to the components identified in the knowledge asset management framework and that there was a good fit with the technologies applied for enablement.

By using the knowledge asset management framework for LSCPs in higher education, the faculty and its lecturers can ensure that the learning- and technology toolset design enables strong support to the community. Whilst students' knowledge and skills are enhanced and new knowledge assets created, stored and made available for future projects. In this way, they can ensure that the complex systems of all parties involved in LSCPs are considered through this knowledge asset approach.

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Theoretical Domain Framework to Identify Cybersecurity Behaviour Constructs

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Abstract. Humans are still the weakest link in the cyber security system. In order to correct cybersecurity behaviour, it is important to understand both the behaviour as well as the cause of the behaviour. In an effort towards the latter, researchers have conducted empirical studies that investigate the constructs of cybersecurity behaviour. This approach has led to a plethora of constructs being proposed as the determinates of cybersecurity behavior. The large number of constructs make it difficult to decide which constructs to focus on when designing cybersecurity behavior interventions. This problem is not unique to cybersecurity behaviour. A similar problem exists in the medical domain. One proposed solution, that achieved good results in the medical domain, is the use of the Theoretical Domain Framework. The contribution of the current paper is a mapping of the constructs found in cybersecurity behaviour, to the Theoretical Domain Framework. This has been achieved by a systematic literature survey. The significance of the study is the identification and of the main behavioural constructs used in the cybersecurity domain. The findings of this research are aimed at being used as a basis when planning theory-based interventions for cybersecurity behaviour change.

Keywords: Cybersecurity · Behavior · Constructs · Theoretical Domain Framework

1 Introduction

The goal for administering cybersecurity behaviour interventions is to curb bad cybersecurity behaviour while promoting good cybersecurity behaviour. Traditionally cybersecurity interventions focus on increasing cybersecurity knowledge [1, 2]. Through further research it is now known that cybersecurity is a behavioural problem as much as it is a knowledge gap problem [3–5]. This means that the designers of cybersecurity intervention must consider behaviour change intervention techniques to influence users.

The paper is presented as follows: Sect. 2 presents a background to the study, Sect. 3 presents the methodology of the study, Sect. 4 presents the results and Sect. 5 concludes the paper.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 320–329, 2019.
https://doi.org/10.1007/978-3-030-35343-8_34

2 Background

2.1 Cybersecurity Behaviour

The current study defines cybersecurity behaviour as an individual's actions, reactions, mannerisms, and general conduct in the cyber domain. The study of behaviour has been a focus of the Psychology domain for centuries; therefore, it is natural that in the strive to understand cybersecurity behavior, psychology principals are investigated.

2.2 Psychology Theory Constructs

Theories in psychology are made up of constructs. Constructs are the different components of the theory. For example, attitude towards the behaviour is a popular construct in many behaviour theories. While difference researchers have studied different constructs that act upon cybersecurity behaviour, it is of interest to this study which of these are more effective for behaviour change.

2.3 Theoretical Domain Framework (TDF)

There exist several behavioural theories, this makes it difficult for behavior change intervention designers to select the appropriate theory. This problem was addressed by Psychological Theorists, Health Service researchers, and Health Psychologists through a collaboration that resulted in the design of a framework called the Theoretical Domain Framework (TDF). The TDF is the result of the identification and summary of 33 behavioural theories as well as 128 theoretical constructs [6]. The TDF was developed for the use in intervention implementation by health care workers [7, 8]. As the use of the framework matured, so too did its adoption in different domains.

2.4 Context of Study

Figure 1 graphically shows the flow of activities when researchers design and implement a cybersecurity behavior intervention:

1. Identify the behaviour to be changed.
2. Identify the behaviour theory to be investigated.
3. Test the different constructs within the theory. Researchers may even introduce new constructs.
4. Based on the results of the construct evaluation, the intervention effort is designed.
5. The intervention effort is implemented.
6. The final step is the evaluation of the intervention effort and the cycle begins again.

2.5 Study Motivation

There exist several behaviour theories, this makes it a challenge for researchers to select which theory to apply to cybersecurity behaviour research. Currently, there exist no standard or methodological manner of theory selection. Adding to the challenges,

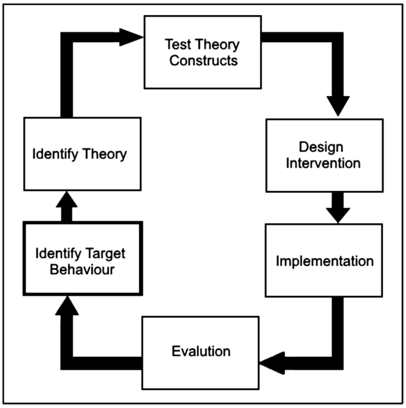

Fig. 1. Cybersecurity behaviour change intervention design and implementation.

researchers have also made modifications of existing theories by adding author defined constructs. Researchers have also made use of different terminology to mean the same or similar constructs. These challenges create confusion when trying to identify an appropriate theory for user cybersecurity behaviour change.

To address these challenges, the current study consolidates different cybersecurity behaviour investigation by mapping the constructs found in the studies to the TDF. The current study addresses the second step in Fig. 1.

3 Methodology

3.1 Search Strategy

1. Google Scholar was initially searched using different combinations of the search terms “Cyber”, “security”, “psychology”, “behaviour”, “theory” and “Cybersecurity”. The resulting publications abstracts’ where scanned for the mention of a behavioural theory. These theories were noted to be used in the next search phase.
2. The academic databases Google scholar and Research Gate were searched using the list of the behaviour theories found in step 1 as well as the terms “cybersecurity” or “cybersecurity”. For Google Scholar, a date filter was set to only included publications which were published between 1999 and 2019.
3. Publications that were available for download were scanned to check if they met the inclusion criteria.

3.2 Criteria for Considering Studies

A publication was included in the study if it met the following criteria:

– The publication is in English
– The study is an empirical study which makes use of a questionnaire/survey.

– The study includes hypothesis testing.
– At least one of the null hypotheses must evaluate the relationship between a construct and the construct “intention to behave” or the behaviour itself.
– The constructs used were either validated by the study or used previously validated constructs.

3.3 Mapping Constructions to the TDF

The refined TDF [7, 9] was used for the study. The constructs of TDF were placed on the spread sheet. Definitions for each construct were extracted from previous literature by looking at both the provided definition as well as associated provided questionnaires [7, 9]. Finally, each construct taken from qualifying literature was mapped onto the TDF based on the definition of that construct provided by the author. See Fig. 2 shows pseudocode of how each construct mapped onto the TDF.

```
foreach TDF Construct:
        {
            foreach Literature Construct:
    {
        compare (TDF Construct Definition, Literature Construct Definition)

            IF (meanings are similar OR the same):
             {
                 place Literature Construct under TDF Construct
             }
             ELSE:
             {
                compare (TDF Construct Example Survey Questions, Literature Construct Survey Questions)

            IF (meanings are similar or the same):
                {
                  place literature Construct under TDF Construct

                 }
           ELSE:
           {
              Add Literature Construct to TDF Construct List
            }
           }

    }
  }
redo the process starting from the last placed literature construct.
```

Fig. 2. Pseudocode for mapping constructs onto the TDF.

4 Results and Analysis

4.1 Results from Literature Search

28 papers of the collected literature met all the selection criteria. The table, at the end of the paper, lists the selected studies. The initial investigation found that: The Theory of Reasoned Action, Theory of Planned Behaviour, Social Cognitive Theory, Health Believe Model and Protection Motivation Theory, were the most commonly used

psychology behaviour theories used in cybersecurity behaviour research. Figure 3 shows the distribution of behaviour theories in the sample literature. Protection Motivation Theory being the most commonly used behaviour theory in the sample set.

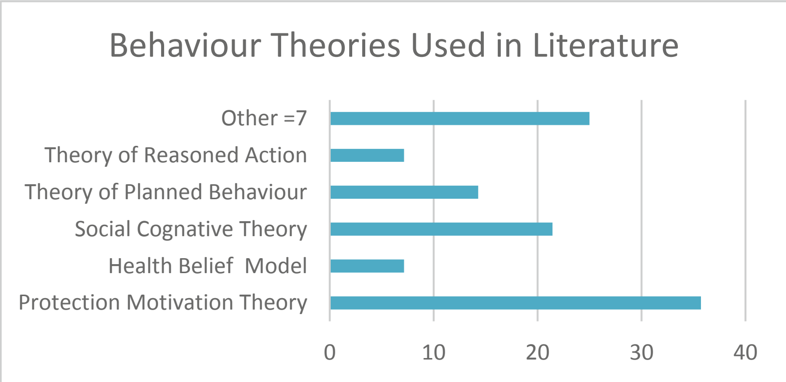

Fig. 3. Behaviour theories found in the sample literature.

4.2 Cybersecurity Constructs Mapped to the TDF

Figure 4 shows the results of mapping the constructs found in the sample literature to the domains of the TDF. From Fig. 4, beliefs about consequences, belief about capabilities and reinforcement are the top three most used domains mapped onto the TDF.

It is interesting to note these domains are very different from each other and would not be tested or evaluated together in system like the one depicted in Fig. 1. The TDF allows researchers to quickly identify the most prominent constructs for a certain behaviour without first having to evaluate several other constructs. The next advantage of the TDF is the ability to zoom in to a specific construct within the domain. From the current literate sample, self-efficacy is the most commonly tested construct for cybersecurity behaviour. This implies that cybersecurity users must feel confident in their ability to perform security related behaviour. The next most commonly tested construct is outcome expectations. Outcome expectations is related to a user's believes that the action taken will be effective or have an effect.

Perceived Susceptibility to threat is a construct not contained in the TDF, however it has been tested a lot in the sample literature. This may suggest that, for cybersecurity behaviour, perceived susceptibility must be added to the TDF.

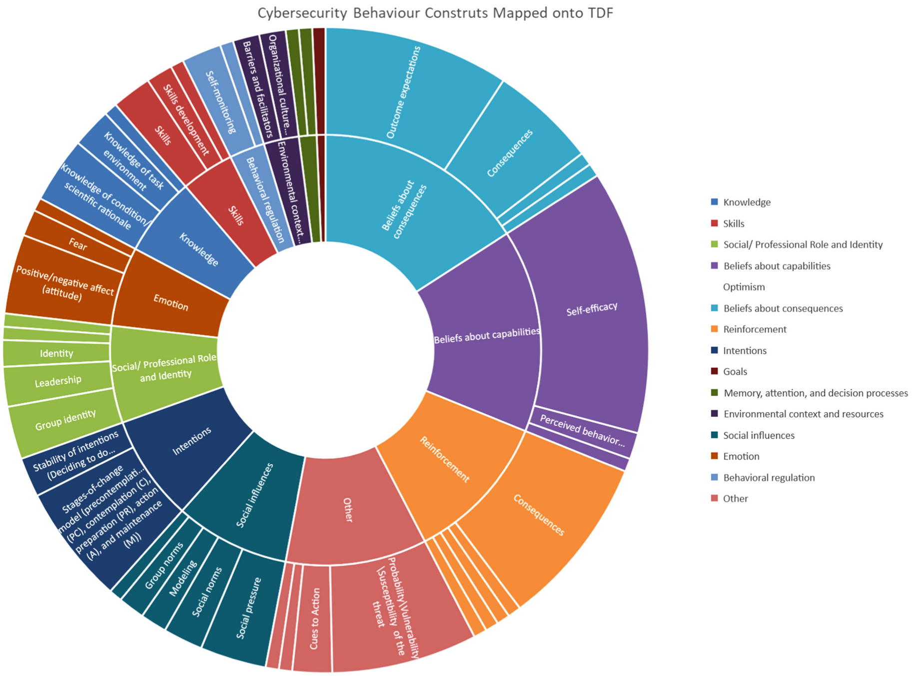

Fig. 4. Cybersecurity behaviour constructs mapped onto the TDF.

5 Conclusion

The current paper set out to identify the most prominent behaviour constructs used in cybersecurity research. The investigation was achieved through a literature study which resulted in the mapping of the constructs onto the TDF.

The results in the study must be considered under the limitations of the study. The first limitation is the sample size of the collected data. Because of the small sample size, the results of these study cannot be generalised. The second limitation is the use of other literature and not primary data.

Future work of the study is the integration the current results with the cybersecurity behaviour taxonomy to form a framework for cybersecurity behaviour change.

Appendix

Date	Author name	Title	Theories	Behaviour
2019	Jansen, Jurjen, and Paul van Schaik	The Design and Evaluation of a Theory-Based Intervention to Promote Security Behaviour Against Phishing	Protection Motivation Theory	Phishing susceptibility
2018	Vishwanath, Arun, Brynne Harrison, and Yu Jie Ng	Suspicion, Cognition, and Automaticity Model of Phishing Susceptibility	Heuristic Systematic Model	Phishing susceptibility
2018	Verkijika, Silas Formunyuy	Understanding Smartphone Security Behaviors: An Extension of the Protection Motivation Theory with Anticipated Regret	Protection Motivation Theory	Security Behaviour on Smartphones
2017	Choi, M., Yair Levy, and Anat Hovav	The Role of User Computer Self-Efficacy, Cybersecurity Countermeasures Awareness, and Cybersecurity Skills Influence on Computer Misuse	Not one specific theory, just constructs	Computer misuse intention
2017	Matias Dodel and Gustavo Mesch	Cyber-Victimization Preventive Behavior: A Health Belief Model Approach	Health Behaviour Model	Anti-virus preventive behaviour
2017	Princely Ifinedo	Effects of Organization Insiders' Self-Control and Relevant Knowledge on Participation in Information Systems Security Deviant Behaviour	Self-Control Theory	Safety behaviour
2016	Tsai, Hsin-yi Sandy, Mengtian Jiang, Saleem Alhabash, Robert LaRose, Nora J. Rifon, and Shelia R. Cotten.	Understanding Online Safety Behaviors: A Protection Motivation Theory Perspective	Protection Motivation Theory	Security intentions
2016	Ashley N. Doane, Laura G. Boothe, Matthew R. Pearson and Michelle L. Kelley	Risky Electronic Communication Behaviors and Cyberbullying Victimization: An Application of Protection Motivation Theory	Protection Motivation Theory	Risky electronic communication behaviours and cyberbullying
2016	Bartlomiej Hanus and Yu Andy Wu	Impact of Users' Security Awareness on Desktop Security Behavior: A Protection Motivation Theory Perspective	Protection Motivation Theory	Security Awareness on Desktop Security Behaviour

(*continued*)

(*continued*)

Date	Author name	Title	Theories	Behaviour
2016	Jurjen Jansen and Paul van Schaik	Understanding Precautionary Online Behavioural Intentions: A Comparison of Three Models	Protection Motivation Theory The Reasoned Action	Online behavioural intentions
2015	Nader Sohrabi Safa, Mehdi Sookhak, Rossouw Von Solms, Steven Furnell, Norjihan Abdul Ghani and Tutut Herawan	Information Security Conscious Care Behaviour Formation in Organizations	Theory of Planned Behaviour The Protection Motivation Theory	Information security conscious care behaviour
2014	Waldo Rocha Flores, Egil Antonsen and Mathias Ekstedt	Information Security Knowledge Sharing in Organizations: Investigating the Effect of Behavioral Information Security Governance and National Culture	Cultural Framework	Information security knowledge sharing
2014	Nalin Asanka, Gamagedara Arachchilage and Steve Love	Security Awareness of Computer Users: A Phishing Threat Avoidance Perspective	Technology Threat Avoidance Theory	Avoiding phishing
2014	Justin Cashin and Princely Ifinedo	Using Social Cognitive Theory to Understand Employees' Counterproductive Computer Security Behaviors (CCSB): A Pilot Study	Social Cognitive Theory	Counterproductive computer security behaviors
2014	Princely Ifinedo	Social Cognitive Determinants of Non-Malicious, Counterproductive Computer Security Behaviors (Ccsb): An Empirical Analysis	Social Cognitive Theory Theory of Planned Behaviour	Non-malicious, counterproductive computer security behaviors (CCSB)
2013	Bo Sophia Xiao and Yee Man Wong	Cyber-Bullying Among University Students: An Empirical Investigation from the Social Cognitive Perspective	Social Cognitive Theory	Cyber-bullying
2013	Sarah Burns and Lynne Diane Roberts	Applying the Theory of Planned Behaviour to Predicting Online Safety Behaviour	Theory of Planned Behaviour	Online safety behaviour
2012	Anthony Vance, Mikko Siponen and Seppo Pahnila	Motivating IS Security Compliance: Insights from Habit and Protection Motivation Theory	Protection Motivation Theory	Influence of habit on IS policy compliance

(*continued*)

(*continued*)

Date	Author name	Title	Theories	Behaviour
2012	Princely Ifinedo	Understanding Information Systems Security Policy compliance: An Integration of the Theory of Planned Behavior and the Protection Motivation Theory	Theory of Planned Behavior The Protection Motivation Theory	Security policy compliance
2010	Anderson, C. L., and Agarwal, R.	Practicing Safe Computing: A Multimethod Empirical Examination of Home Computer User Security Behavioral Intentions	Protection Motivation Theory	Home computer user's intention to protect the Internet and own computer
2010	Johnston, A. C., and Warkentin, M	Fear Appeals and Information Security Behaviors: An Empirical Study	Technology Adoption Fear Appeal Theories	Compliance of end users
2009	Tejaswini Herath and H.R. Rao	Encouraging Information Security Behaviors in Organizations: Role of Penalties, Pressures and Perceived Effectiveness	Intrinsic and Extrinsic Motivators in Information Security Behaviours	Information security policy compliance
2009	George R. Milne, Lauren I. Labrecque, and Cory Cromer	Toward an Understanding of the Online Consumer's Risky Behavior and Protection Practices	Protection Motivation Theory Social Cognitive Theory	Consumers' perception of the threat and likelihood of threat associated with online experiences
2009	Ng, Boon-Yuen, Atreyi Kankanhalli, and Yunjie Calvin Xu.	Studying Users' Computer Security Behavior: A Health Belief Perspective	Health Belief Mode	Computer security behavior
2009	Hyeun-Suk Rheea, Cheongtag Kimb, Young U. Ryuc	Self-Efficacy in Information Security: Its Influence on End Users' Information Security Practice Behavior	Social Cognitive Theory	Security practice behaviour
2009	Tim Chenoweth, Robert Minch and Tom Gattiker	Application of Protection Motivation Theory to Adoption of Protective Technologies	Protection Motivation Theory	Adoption of Protective Technologies
2007	Mikko Siponen, Seppo Pahnila, and Adam Mahmood	Employees' Adherence to Information Security Policies: An Empirical Study	Protection Motivation Theory General Deterrence Theory Theory of Reasoned Action	Policy compliance
2006	S. Chai, S. Bagchi-Sen, C. Morrell, H. R. Rao and S. Upadhyaya	Role of Perceived Importance of Information Security: An Exploratory Study of Middle School Children's Information Security Behavior	Social Cognitive Theory Self-Efficacy	Information Security Behaviour on the Internet

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The South African ICT Security Awareness Framework for Education (SAISAFE)

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Abstract. The literature review and the investigations that have been conducted show that there is a need for a framework that would integrate ICT security awareness into the South African education system. The state of the current usage of ICT in South Africa was investigated as well as the level of ICT security awareness among South African school learners. A gap analysis between the two spheres of ICT security awareness and ICT in education showed that there was indeed a problem. A vigorous research methodology using among others an extensive questionnaire and themes was used to propose a framework that would attempt to provide a solution to the identified problem. After receiving feedback from the research participants, the proposed framework underwent an analysis phase and it was improved and the responses were incorporated to it. A framework called the South African ICT Security Awareness Framework for Education (SAISAFE) has been proposed in this research. This paper presents the process that was undertaken in order to formulate the proposed framework. The complete proposed framework and a brief description of its components are also presented in this paper.

Keywords: ICT · ICT security awareness · Education · Framework · SAISAFE

1 Introduction

There has been a vast increase in the usage of Information and Communication Technology (ICT) among school learners in South Africa. According to the study that was done by Kreutzer [1] in Cape Town, South Africa has seen a huge increase in ICT usage among school learners. Unfortunately, in general, ICT usage often introduces a number of risks and vulnerabilities, such as social engineering, cyber bullying, identity theft, exposure to pornographic content, and many more. On this premise, it is vital that ICT security awareness is introduced to South African school learners while they are still young as opposed to later on in their lives. This paper presents a framework that can be used to integrate ICT security awareness into the South African education system. The research questions of this paper is "What framework can be used to integrate ICT security awareness into the South African education system?".

South Africa uses ICT in all spheres of industry – in academia, in business, in sports, in government departments – to name but a few. The increasing usage of ICT in South Africa has obviously triggered wide concern about ICT security awareness. In

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 330–339, 2019.
https://doi.org/10.1007/978-3-030-35343-8_35

recent years, a growing number of ICT-related crimes have been reported in South Africa [2], ranging from cyber-attacks to online banking fraud conducted at one of the largest banking institutions in the country.

The ICT-related crimes have led to the conclusion that there is a lack of ICT security awareness in South Africa. The researcher chose the education system in order to instill the discipline and knowledge of ICT security to school learners while they are young. Research shows that ICT security has not yet been added into the South African school curriculum [8]. Therefore the research was conducted to assist with the integration of ICT security awareness into the South African education system.

In an attempt to provide a solution to the problem of the lack of ICT security awareness in the South African education system, an in-depth literature review was conducted. This enabled the researcher to understand the usage of ICT in South Africa as well as the current state of ICT security awareness among South African school learners. Six models and frameworks in ICT security awareness and ICT in education were identified to be used to determine if there was a gap between the two spheres. A gap analysis table was used to analyze these two spheres and to determine if there was indeed a gap between them. Once a gap had been identified, key components within the models and frameworks were selected and were used to formulate the initial proposed framework.

The framework was sent through a questionnaire to a focus group of experts in the fields of ICT security to get their views and opinions on the proposed framework. The eight experts who participated in the evaluation have an average of fifteen years of experience – both in the ICT security industry and in academia in South Africa. After receiving the responses and feedback from the experts, the framework was analyzed and feedback was incorporated into an improved framework and the final version of the framework was formulated. The sections and subsections in this paper illustrate the process that was undertaken to get the finalized framework. The research design that was implemented in this research is discussed in the following section.

2 Literature Review

In an effort to understand the state of ICT security awareness among South African learners, an in-depth literature review was conducted. The sub-sections that follow present the literature review that was conducted.

2.1 ICT Security Awareness Among School Learners in South Africa

Despite the proven increase of the usage of ICT among school learners in South Africa [1, 4, 5], literature is still showing that there has been no inclusion of ICT security awareness in the school curricula [3]. Even though there have been numerous calls to include it in the curriculum, ICT security awareness has still not been included into the South African schools' curricula. Kritzinger and Von Solms [4] are of the view that it would be beneficial for school learners to start learning about ICT security awareness from a young age. This would assist them to be better prepared for the dangers associated with the usage of ICT.

Referring to the growing usage of ICT usage among school learners in South Africa in urban as well as in rural areas, Walaza et al. [5], proposed the dissemination of ICT security awareness information and material in public areas like libraries and hospitals to make people more informed about ICT security. They also proposed the usage of indigenous languages when disseminating ICT security information so that it can be understood by everyone that is literate. Research has shown that people learn better when they are taught in their own mother-tongue. These are but some of the initiatives that have been proposed in order to assist to raise the level of ICT security awareness among South African school learners.

2.2 ICT Security Awareness in Other Countries

Like in other countries around the world, ICT security awareness is also a problem in other African countries. According to Williams, Maharaj and Ojo [6], Nigeria has seen a significant increase in ICT-related attacks in recent years. Even though there are similar ICT security problems in Europe, the European Union has implemented some initiatives aimed at improving ICT security awareness [7]. This shows that ICT security awareness is not only a problem in South Africa, but it is a problem world-wide.

2.3 The Models and Frameworks That Were Used in This Research

In an attempt to address the problem of the lack of ICT security awareness among South African school learners, the researcher made use of six models and frameworks from the two spheres of ICT security awareness and ICT in education. The ICT security awareness models and frameworks were: The Business Model for Information Security, the Information Security Retrieval and Awareness Model, and the Comprehensive Information Security Framework. The ICT in education models and frameworks were: the Four In Balance Model, the Teacher Development Framework, and the Model for ICT Rural Education.

The six models and frameworks were carefully selected among many because of their similarity towards the objective of this research. Having identified a gap between the two spheres, twenty-four building blocks (themes) were coded to be included in the proposed framework. After an inductive analysis and iterations for the selection of relevant themes, the building blocks were scrutinized and reduced to thirteen. The thirteen building blocks were then grouped in such a way that they would form a meaningful framework that would assist to integrate ICT security awareness into the South African education system.

3 Research Design

3.1 The Research Method

The qualitative research method has been used in this research. According to Creswell [8], the qualitative research method makes use of literature reviews, focus groups and structured online questionnaires to collect data. An in-depth literature review was used to identify themes (building blocks) that would be used to construct the proposed framework.

3.2 The Research Philosophy

During the literature review process of this research, a gap was identified between the two spheres of ICT security awareness and ICT in education. The identification and interpretation of the trends of ICT security awareness among South African school learners was deemed necessary. Therefore, the research philosophy that was implemented in this research is interpretivism. According to Olivier [9], the goal of interpretive research is to understand that which is being studied. Interpretivism was therefore used to understand the state of ICT security awareness among South African school learners, as well as to identify the gap that exists between the two spheres of ICT security awareness and ICT in education.

3.3 The Research Approach

During the formulation and creation of the proposed framework, an inductive research approach was used. According to Creswell [8], with the essence of the research objectives, the inductive approach can be utilized to formulate a framework. Therefore, themes and codes (building blocks) were identified from raw data and used to construct the proposed framework. Figure 1 depicts the approach that was used in this research.

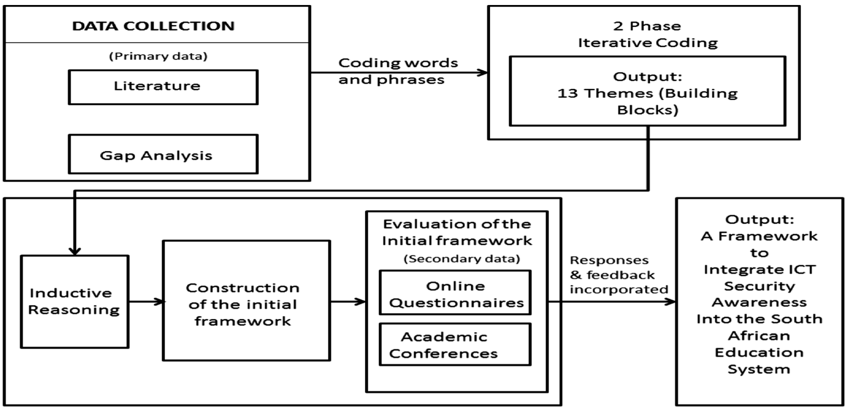

Fig. 1. Inductive approach (based on [10]).

The primary data was sourced from literature and the gap analysis table and secondary data was sourced from academic conferences and online questionnaires respectively. The data was analyzed using codes and themes (building blocks) that would be used to formulate the proposed framework. The data that was acquired from the online questionnaires and academic conferences was interpreted to make a preliminary evaluation of the framework. Figure 1 depicts the research process that is aligned to the inductive approach that was used in this research.

3.4 Data Analysis

An online questionnaire was used as a data collection technique in the pilot study of this research [11]. The aim of this online questionnaire was to obtain the views and opinions of participants regarding the proposed framework. Thirteen open-ended interview questions were used in this research and the online questionnaires were sent to experts in their respective fields.

The data that was received from the online questionnaires and the literature review was analyzed by inductive reasoning. According to Swanepoel [10] the inductive approach involves the construction of a framework that reflects a research objective from raw data collected during research. This raw data constitutes peer-reviewed academic research papers and articles that were written and published in the past five years. This constitutes the analysis that was conducted in this research.

3.5 The Research Strategy

The research strategy that was implemented in this research was phenomenology. The reason for choosing this strategy was that an understanding of the phenomenon of ICT security awareness among South African school learners (between seven and thirteen years old) was required. This under-standing of the phenomenon would eventually be used in the formulation of the proposed framework.

3.6 Verification

The verification process included peer-reviewed academic conferences which were used to present research articles about the proposed framework. The feedback and data that was received from the conferences and the responses from the online questionnaires were analyzed and incorporated into the final version of the proposed framework. Even though a fully-fledged proof of concept was not done, the responses received from the online questionnaires showed that the framework had the potential to be useful.

4 The End Result (SAISAFE)

After going through all the necessary phases of constructing a framework, the SAISAFE framework was finalized. The coding process resulted in themes (building blocks) that were grouped and ordered in such a way that a meaningful framework was formulated. The aim was to produce a framework that would be relevant to South Africa and one which would assist to integrate ICT security awareness into the South African education system. Figure 5 below depicts the proposed framework (SAISAFE). The sections that follow provide an overview of the components and subcomponents of the proposed framework.

4.1 Leadership and Governance

The Leadership & Governance component is a building block that was derived from the Comprehensive Information Security Framework (CISF) [12]. According to Da Veiga [12] this component provides strategy and direction to the implementation of the CISF and will provide the same functionality in the proposed SAISAFE. The main custodians of ICT in South Africa (the South African government) and the Department of Education will have to play a leadership and governing role when it comes to the integration of ICT security awareness into South African education. The Leadership and Governance component refers to the custodians of ICT in South Africa and it is inter-connected with the three components that are in the middle (Documentation, Collaboration & Support, and People).

4.2 User Awareness

The User Awareness building block was also derived from the Comprehensive Information Security Framework (CISF), which according to Da Veiga [12], can be used in different types of environments. The User Awareness component is responsible for ICT security awareness in this research, and programmes to ensure ICT security awareness among South African school children will be discussed extensively as part of this component. User awareness plays a critical role in this research and will include various sub-components to assist with the integration of the two spheres (ICT security awareness and ICT in Education).

4.3 Documentation

The Documentation component is a building block that was derived from the Information Security Retrieval and Awareness (ISRA) model [13]. Kritzinger [13] states that the aim of the ISRA model is to enhance information security awareness among employees of an organisation. This building block will be used for all the documentation that is relevant to ICT security awareness in South African schools. Within this component are sub-components that depict the various ICT security awareness documents available in literature. They will be used to ensure the effective integration of the two spheres.

Figure 2 depicts the four sub-components within the Documentation component, namely Information Security Documentation; Code of Best Practice; Policies and Standards; and Incident Management. The purpose of this component is to record and document all relevant and important information relating to ICT security awareness and ICT education. This documentation will be used for the purposes of this research, to assist with the integration of ICT security awareness into the South African schooling system.

4.4 Collaboration and Support

The Collaboration and Support component is a building block that was derived from the Four In Balance Model. Draper [14] highlights teacher expertise as an important

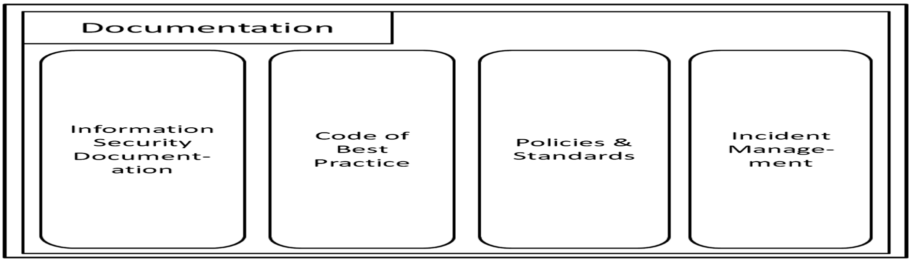

Fig. 2. The documentation component.

component of this model because teachers are the ones responsible for the safe usage of ICT in schools. In this research, the Collaboration & Support component will play the role of integrating the two spheres (ICT security awareness models and ICT-in-Education models) and it contains a number of sub-components that are used to ensure the integration of ICT security awareness into South African schools. Some of the additional sub-components introduced in this research will also be discussed within this component. Figure 3 depicts the Collaboration & Support component of the proposed framework.

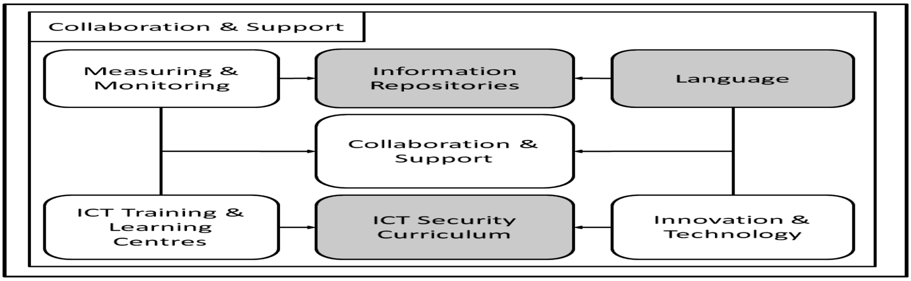

Fig. 3. The collaboration and support component.

The four sub-components that are within the Collaboration & Support component are Measuring & Support, Collaboration & Support, ICT Training & Learning Centres, and Innovation & Technology. The current research also introduced three new components to make the proposed framework relevant to South Africa; these new components are Information Repositories, Language, and ICT Security Curriculum. The rest of the components are discussed in the upcoming paragraphs.

The Collaboration & Support component is located in the middle of this framework and consists of four sub-components, namely: Measuring & Monitoring, Collaboration & Support, ICT Training & Learning Centres, and Innovation & Technology. The Innovation & Technology sub-component incorporates the introduction and usage of artificial intelligence (AI) in the South African education system. The usage of AI will improve the quality of education in the country.

The sub-components within this component are linked together to show that each one is related to another and is just as important as the other. Collaboration & Support is the most important component of this framework because it connects all the other components with each other.

4.5 People

The People component is a building block that was derived from the Business Model for Information Security [15] model. ISACA [15] boasts that this model can be used in any type of organization, hence it is also relevant for this research. The People component is responsible for all the human aspects in this research, and depicts and clearly defines the role played by each of them. The various human aspects will be depicted as sub-components within the people component. The proposed new sub-component, the ICT Security Ombudsman, will also be included. Figure 4 depicts the People component of the proposed framework.

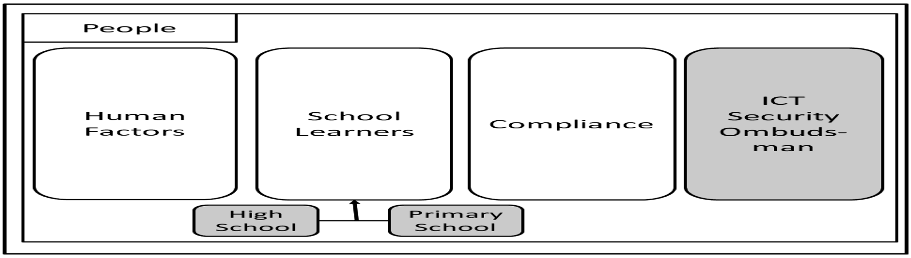

Fig. 4. The people component.

The sub-components within the People component are Human Factors, School Learners and Compliance, as well as the new subcomponent, the ICT Security Ombudsman, which was introduced by the current research in order to make the proposed framework relevant to South Africa. The School Learners subcomponent introduces two further elements called High School and Primary School. These and the rest of the subcomponents under the People component are discussed in the following paragraphs.

The People component consists of four sub-components, namely Human Factors, School Learners, Compliance, and ICT Security Ombudsman. This component is associated with the human aspect of this framework. All the sub-components within this component refer to human aspects of ICT security awareness in education. The People component is linked to the Collaboration & Support component as well as to the Leadership & Governance and User Awareness components. Both the flow and the relationship between the various components of the SAISAFE are clearly depicted in Fig. 5.

The components in the framework are all connected by means of arrows to indicate the dependability of the components on each other. The joining arrows indicate that no component exists on its own, and that all components work together to integrate ICT

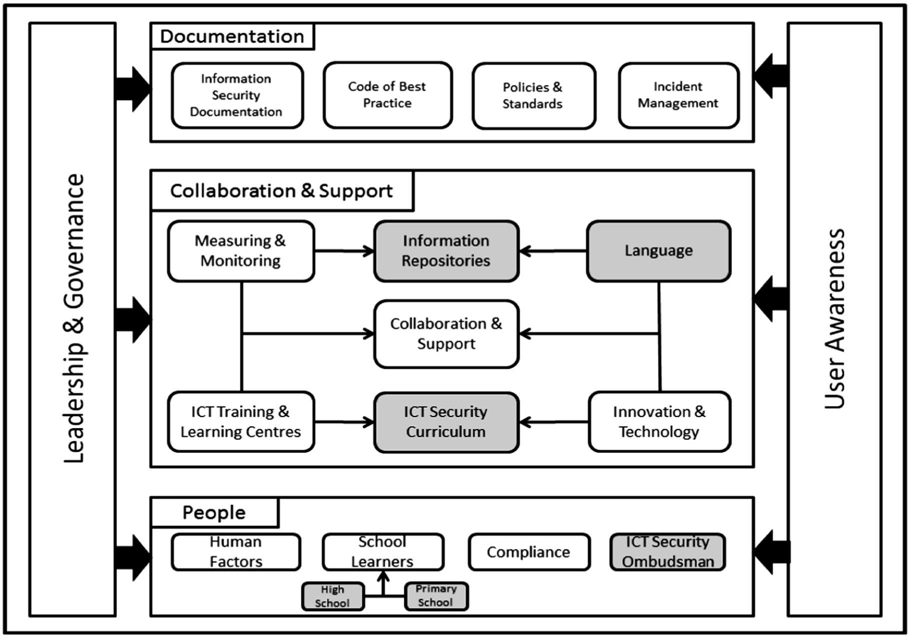

Fig. 5. The SAISAFE.

security awareness in South African schools. The newly proposed sub-components and elements are colored in grey within the framework so as to distinguish the components that were derived as building blocks from existing models and frameworks.

The main purpose of the SAISAFE is the integration of ICT security awareness in South African education. The in-depth literature that was conducted in this research indicated that the existing models and frameworks were not relevant to South Africa. Hence a new framework relevant to South Africa – the SAISAFE – was proposed.

The thirteen building blocks that were selected through the coding process were: leadership & governance, user awareness, information security documentation, policies and standards, code of best practice, human factors, collaboration and support, ICT learning and training centers, measuring and monitoring, innovation and monitoring, incident management, compliance, and school learners. The building blocks that are colored in gray represent the themes that were introduced in this research as opposed to the ones that were coded from literature. The arrows that join the different building blocks within the framework depict the inter-dependence of one theme from another.

5 Conclusions and Future Research

The initial construction phase of the SAISAFE has been concluded. The various phases of the construction of the framework have been scrutinized by experts in the fields of ICT security and ICT in education. This research described some unresolved issues in

ICT security awareness in the South African education system and it then presented a framework that would integrate ICT security awareness into the South African education system.

The next phase of this project is the long-term implementation and verification of the proposed framework. This phase involves getting the framework implemented and observed over a period and having its results analyzed.

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Educational Data Analytics Techniques and Adaptive Learning Applications

Research on the Application of Graphic Method in Formative Evaluation of Teaching Chinese Characters to Foreign Students

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Abstract. It is difficult and important to teach Chinese characters to foreign students. Graphic method has the property of visibility, so it is appropriate to use this method in the teaching Chinese as a foreign language. In order to verify the practical effect of the graphic method, a study was conducted and formative evaluation system was established. The research results shows that the graphic method is helpful to students' understanding and memory, to enhance the students' interest in learning. So it is beneficial to use graphic method in the teaching.

Keywords: Graphic method · Formative evaluation · Teaching Chinese characters to foreign students

1 Introduction

With the improvement of China's comprehensive national strength and international status, more and more foreigners begin to have a strong interest in Chinese, Chinese is regarded as the second foreign language in schools at all levels, the number of people coming to China to study Chinese is also increasing year by year, an unprecedented "Chinese fever" being appeared in the world. Teaching Chinese as a foreign language (TCFL) is not only the important carrier of propagating Chinese, but also an important communication of culture. In the process of teaching Chinese, teaching method in classroom is occupying the important position, the effect of teaching directly affects the transmission of language and culture all over the world. so the establishment of the evaluation system in TCFL is very important to the discipline construction. A scientific and reasonable evaluation method can not only stimulate students' interest in learning, enhance their autonomy and improve learning efficiency, but also help teachers to observe the classroom, enhance teaching methods and improve teaching quality.

As one of the teaching evaluation methods, formative assessment mainly focuses on stimulating students' participation in class, providing timely and effective feedback for teaching and learning, and contributing to the virtuous cycle of "teaching-learning-teaching". Therefore, it is necessary to establish a time-saving and efficient formative

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 343–350, 2019.
https://doi.org/10.1007/978-3-030-35343-8_36

evaluation system in TCFL class. Graphic method has visibility and can effectively make students have a clear mind. In order to prove that graphic method is a relatively optimal teaching strategy in teaching Chinese characters 0f TCFL, a research was conducted. In the research, a quantitative table of formative assessment is established, and the teaching effect of graphic method by using the formative assessment in practical application was analyzed and studied.

2 Theoretical Analysis

2.1 Analysis of Formative Assessment

The Contents of Formative Evaluation

Formative assessment is an assessment on the performance, achievements and development of feelings, attitudes and strategies reflected in the course of routine study of students.

This concept was formally proposed by Scriven, an American expert on evaluation, in his book of *The methodology of evaluation in* the 1960s [1]. According to Scriven's understanding, formative evaluation collects, synthesizes and analyzes the information of students' daily learning through multiple channels, attaches importance to the evaluation of students' knowledge acquisition, skills acquisition and attitude formation, and focuses on the development of students' potential.

In the 1970s, the American educational psychologist Bloom further perfect this theory. He divided the "teaching" and "learning" processes of a subject into three stages: the beginning of teaching activities, the teaching process and the teaching objectives, and proposed the evaluation methods of diagnostic evaluation, formative evaluation and summative evaluation throughout the three stages [2]. The formative evaluation is generally carried out in the teaching process to understand the effect of teaching and explore the problems of teaching so that the teaching work is adjusted. It not only pays attention to the evaluation of students' cognitive ability but also attaches importance to the evaluation of students' emotional and behavioral ability.

This evaluation method has broken the traditional cramming method of teaching, which is characterized of changing students from passive acceptance to active participant, and has a promotional effect on the cultivation of students' logical thinking ability and innovation ability.

The Subject of Formative Valuation

The subject of formative evaluation is mainly the evaluation of teachers and students. The evaluation of teachers includes peer evaluation, students, supervision evaluation and teachers' self-evaluation. The evaluation of students come from the teachers, the classmates and students' self-evaluation. In order to prove the effectiveness of graphic method in teaching Chinese characters to foreign students, this paper mainly constructs a formative evaluation system of students.

The Quantitative System of Formative Evaluation

According to the concept of formative assessment, it can be concluded that the indicator system of formative assessment includes: the structure of students' learning knowledge and achievement in class, the expression of students' emotion, the strategy of students' independent learning, and so on.

The Advantages of Formative Evaluation

Formative evaluation accurately and effectively evaluates teachers' teaching and students' learning from two aspects of teaching and learning. First, It can focus on the process of students' learning and improve their initiation. Secondly, because of the gradual process of the learning, formative evaluation can more comprehensively measure the whole process. Finally, formative assessment enables teachers to understand the process of students' learning. Through understanding and feedback, teachers can adjust and promote teaching again. The purpose of formative assessment is to reflect the learning process of students more objectively and to further implement the teaching concept of "student-centered".

2.2 The Analysis of Graphic Method

The Conception of Graphic Method

Schema theory is used to explain and understand psychological processes by cognitive psychologists. It was first proposed by German philosopher and psychologist Kant in 1781. He believed that there were pure concepts in the human brain, and schema was the link between concepts and perceived objects.

Because the schema concept helps explain complex social cognitive phenomena, it was quickly adopted by social psychologists. Since the 1990s, schema theory has been applied to the field of intercultural communication. Compared with other theories, schema theory has both description and interpretation functions, and can carry out some empirical research, so it should be paid attention to.

In this paper, the graphic method is the specific application of schema theory. Graphic method is a comprehensive approach of using characters, symbols, pictures, colors and other intuitive graphics to analyze, ponder, recognize Chinese characters. Graph is the universal language in the world, and people from different languages have roughly the same understanding of it. In the teaching Chinese characters as a foreign language, the use of graphic method can help to visualize the unfamiliar abstract Chinese knowledge and express the complicated things in a concise way, so as to enhance the interest in learning Chinese and facilitate the memorization, master and application of Chinese language.

The Theoretical Basis of Graphic Method

From the cognitive science B·A kreutsky, an famous psychologist of the former Soviet union, once pointed out that "vision plays A leading role in people's understanding of the external world" [3]. Treichler, a psychologist, proved through experiments that human beings get information 83% from vision, 11% from hearing, 3.5% from smell, 1.5% from touch and 1% from taste. As a result, up to 94% of the information is obtained through sight and hearing. Other experiments have shown that it is easier to make semantic connections explicit by means of image coding.

From the neurophysiology of brain. The two hemispheres of the human brain have different functions. The left hemisphere usually processes digital information, such as language and numbers. The right hemisphere is responsible for processing analog information, such as symbols, images, music, etc. that is, processing image information [4]. The graphic teaching method transfers the language information processed by teachers to the visual nerve and auditory nerve of learners at the same time, by combining the language knowledge with the image symbols, so as to stimulate both hemispheres of learners' brain to think simultaneously.

From the theory of memory American cognitive psychologist D.D. Ausubel had put forward two kinds of "learning" theories, which divided memory into mechanical memory and meaningful memory. For most information, it is necessary to give meaning to the information, stimulate the memory based on understanding and refine the information. Such memory is not based on rote learning, but on understanding. The illustration can exactly promote and deepen learners' understanding of the problem. Compared with mechanical memory, it is more effective to store the knowledge learned in the brain to form long-term memory and extract it immediately when needed.

3 Research Design

3.1 Research Objects and Methods

The Object of Study

In this study, twenty-one foreign students were chosen whose native language was pinyin characters in the fall semester of 2018. They were randomly divided into two classes: Class 201801 (11 persons) was the Conditional Control Group, and Class 201802 (10 persons) was the Experimental Group. The foreign students were selected as the research object in the spring semester of 2019, whose mother tongue is also pinyin characters, Class 201901 (11 persons) is the Conditional Control Group, Class 201902 (10 persons) is the Experimental Group. All the students in the class are entry-level students. Before the study, an experiment was conducted to understand the level of Chinese characters. The experimental results showed that all student do not learn and write Chinese characters and they are no significant differences in the level of Chinese.

Teaching Arrangement

The other conditions of the experimental group and the control group are the same. There are 4 classes per week for teaching Chinese characters leaving no homework after classes. The experiment of each semester academic lasts two weeks.

Textbook, Teacher, Teaching Methods

80 Chinese pictographs commonly used are selected by teachers for teaching materials; Four classes in two semesters are taught by the same teacher. The teacher has some foundation of philology and teaching experience, understands the knowledge of formative evaluation, and has the sense of responsibility. The control group was taught by traditional teaching methods of writing and reading in the classroom. The graphic method was added to the teaching of Chinese characters in the experimental group, at

the time formative evaluation was carried out in the teaching process. Chinese characters, as the only hieroglyphic existing in the world, has thousands of years history. this ancient characters imitated human and human body, animals, plants and natural objects; Most of them expressed the meaning of words on the basis of imitation, so the pattern of Chinese characters have a high degree of resemblance to the meaning.

In the multimedia teaching environment, the teacher demonstrated the evolution of Chinese characters with the form of animation, at the same time add concrete pictures. In the process of teaching, the students' classroom performance were observed and recorded. The teacher also made enquiry about students' other information after school and made good records. Through the feedback of students, teaching methods and course were adjusted by the teacher (Tables 1 and 2).

Table 1. Commonly Used 80 Chinese Pictographs [5].

人	口	手	足	舌	牙	耳	目	金	木	水	火	土	石	田	土
虫	贝	鱼	鸟	羊	犬	龟	鹿	丝	麻	毛	皮	竹	禾	米	谷
日	月	星	光	云	电	风	雨	衣	食	住	行	父	母	儿	女
出	入	开	关	坐	卧	立	走	东	西	南	北	前	后	左	右
刀	戈	弓	矢	牛	马	车	舟	羽	角	齿	革	瓜	果	麦	豆

Evaluation of Experimental Results

After the experiment, two classes of students were tested every semester. The test included dictation and recognition. Firstly, the teacher read the Chinese characters three times, then students written them on the paper; Secondly, the teacher gave the Chinese characters to the students before the students written the meaning in English.

Questionnaire survey method students in the experimental group were investigated about graphic teaching methods.

Interview method objects of investigation were selected including some students in the control group and experimental group, teacher of teaching Chinese characters, some teachers of other departments.

Results and Analysis

Analysis of quantitative results (Table 3):

Table 2. A quantitative table for formative assessment of students' daily life.

Knowledge structure	Comprehension	Memory	Writing	Literacy	Reading	Keeping
Attitude structure	Attendance	initiation	Answer question			
Strategy of learning independently	Review, previews	Extra-curricular counseling	Extra-curricular reading			

Table 3. Comparison of learning effects among students

Group	Item	The correct number for Class 2018											Accuracy
Control	Dictation	20	25	31	26	40	52	27	56	15	18	35	43.1%
	Identification	35	28	40	27	30	47	20	50	14	17	31	42.3%
Experimental	Dictation	80	68	63	69	73	80	75	70	65	71		89.2%
	Identification	80	65	80	78	75	80	80	76	75	78		95.8%
Group	Item	The correct number for Class 2019											Accuracy
Control	Dictation	45	29	26	45	54	26	53	28	27	35	23	48.8%
	Identification	27	34	42	26	36	47	25	45	35	38	40	49.3%
Experimental	Dictation	74	62	73	72	6	75	80	69	80	70		90.3%
	Identification	76	63	67	78	80	80	73	70	69	75		91.3%

From the above Table, the final test results of the experimental group and the control group are quite different. The score of the experimental group is above 80% on average. So can the difference be attributed to the students' development of natural teaching rather than the results of experiments? Both the students in the experimental group and the control group are junior levels, who had not been exposed to Chinese before, and The environments of their living and learning were roughly the same. In order to ensure the effectiveness, two different semesters of junior international students were selected for the experiment, and the difference between the two also reached much. It shows that the differences can not be attributed to the process of natural teaching development, but to the results of experiments. In order to further confirm this point, a questionnaire survey was conducted on the students in the experimental group, and the chart results are shown as follows (Table 4):

Table 4. Questionnaire survey of the experimental group on the formative evaluation of graphical method.

Investigation projects	A Yes	B among yes/no	C No
Whether or not like graphic method	99%	1%	0
Helping to understand	97%	3%	0
Making myself more and more interested in Chinese	98%	1%	1%
Motivating to learn	98%	2%	0
Improving capacity of problem-solving	95%	5%	0
increasing burden	0	4%	96%

The survey results show that almost all the students believe that the graphic method is an effective teaching method, which is helpful for students to understand Chinese characters, remember Chinese characters in a short time, and enhance their confidence in learning Chinese characters. This further proves that the graphic method is an effective method in teaching Chinese characters to foreign countries.

4 Analysis of Interview Results

The interview results of students in the control group of grade 2018 and 2019: The main problems were recorded including Chinese characters difficult to recognize and memorize, the boring of Chinese characters class. The students mainly imitates the Chinese characters and memorize their meanings in English. After class, the students seldom practice writing Chinese characters.

The interview results of the teacher: the classroom atmosphere in the control group was dulling, and the students did not ask questions. They mechanically imitated the Chinese characters in order to remember, and used their native language to remember the meanings of Chinese characters. Some students did not even come to Chinese characters class. Therefore the traditional teaching method cannot last too long, it will cause students to be afraid of learning Chinese and lose the confidence of learning. The classroom atmosphere in the experimental group was enjoyable. After the explanation of each Chinese character, the students could understand the meaning of the Chinese character in class and remember the words very quickly. The students took an active part in writing Chinese characters.

The interview results of teachers about other courses: the class atmosphere of the control group was dulling, students did not like to answer questions, and students thought Chinese was too difficult to learn. They had not enough confidence in learning Chinese. Otherwise Students in the experimental group liked to discuss and ask questions, they showed the interest and enthusiasm to learn Chinese.

5 Discussion and Conclusion

5.1 Reconsideration of the Graphic Method

Some teachers think that elementary course for foreign students is very easy, and do not need some methods. Students need to have the ability of reciting and writing. Some teachers have not the foundation of Philology, and can not explain the Chinese characters from the origin, so they explain the Chinese characters in English or only download photos from the Web. These teaching methods need to be reconsidered. On the one hand, the method of mechanical memory constrained the minds of students, students can't give full play to their imagination. On the other hand, Students cannot form the habit of thinking of Chinese from the beginning, because the teachers explain the meanings in English. In the long run, it is disadvantageous for students to learn Chinese well.

5.2 The Weak Points of the Experiment

Firstly, foreign students whose mother tongues are pinyin characters were selected in this experiment, and students from Japan, Korean or other countrys whose mother tongues contains Chinese characters were excluded the research. These students have been exposed to Chinese characters. It needs to be further proved Whether the pictorial method is beneficial for them. Secondly, In the experiment, the motivation and learning strategies of foreign students in learning Chinese were not analyzed, which will more or less affect the results of the experiment. Thirdly, the relationship between the results of formative assessment and students' learning effects is not demonstrated. At last, The duration of the experiment was short, and other factors were not excluded. All of these questions need to be further confirmed in future experiments.

5.3 Conclusion

Although there are shortcomings, the conclusion can be drawn from the experiment: graphic method is an effective teaching method in teaching Chinese as a foreign language, which is helpful for students' understanding and memory, enhancing students' interest in learning, and facilitating the good development of teaching activities. The pictorial method should be used not only in the primary stage, but also in the course of phonetics, vocabulary and grammar. It is necessary to establish a digital resource database of graphic images. Teachers should actively explore effective graphic methods to enhance students' interest in learning Chinese.

Acknowledgment. This research is funded by the International Joint Research Promotion Program, International Joint Lab (Knowledge Media Dynamics in Educational Fields) of Osaka University & Northeast Normal University, and MOE (Ministry of Education in China) Project of Humanities and Social Sciences, Research on Visualization Teaching Model of Foreign Language Based on Big Data of Education (Project No. 18YJCZH088).

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An Empirical Analysis on Standards for Selecting News About Current Events for Case-Based Teaching of International Laws

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Abstract. How to select current events is decisive for teaching effects of international laws. The author proposes based on years of practical teaching experiences in international laws that selected current events shall be pertinent, timely, appropriate and extensible. This paper intends to empirically analyse if these four standards for case selection are favourable for improving teaching of international laws. The research findings of this paper are as follows: (1) Observe if the four standards for selecting cases about international laws are easy to practise in routine teaching of international laws; (2) arrange tests for students to confirm if these standards for case selection are helpful for teaching international laws.

Keywords: International laws · Current events · Selection standards · Case evaluation · Empirical analysis

1 Introduction

News about current events, with substantial influence upon the society, may arouse widespread concerns of the society. They are characterized by timeliness, significant impacts and great concerns. Hence, it is helpful for enhancing students' enthusiasm, making teaching cases more fit for taught knowledge and improving timeliness of teaching international laws. Professor Joyner (Georgetown University, U.S.) has supported this view that: "International law must function in a real-world political environment, and simulation exercises should reflect that fact" [1]. Hence, how to select news about current events is critical for teaching of international laws.

At present, very few studies have been conducted on selection standards for cases with respect to current events of international laws in China. Nevertheless, some legal education workers have noticed the importance of these standards for case-based teaching of laws [2]. Thus, some of them have proposed that rigorous standards for case selection should be established in their case-based teaching. For example, Professor Zejian (Taiwan University, Taiwan China) has pointed out: "if cases shall be selected according to more rigorous standards in order that the cases discussed by

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 351–356, 2019.
https://doi.org/10.1007/978-3-030-35343-8_37

students are more representative" [3]. Furthermore, Professor Hall (Indiana University, U.S.) has put forward his view that: "case method presupposes and requires careful preparation in advance of the class discussion" [4]. But neither Professor Zejian nor Professor Jerome Hall has further put forward particular standards for case selection. Professor Wusheng (Fudan University, China) has put forward the requirement for case selection in his article "Promotion of Whole-process Case Method" (2013): "To select a case, if it is difficult or not shall be taken into account. Moreover, the case is expected to cover relatively many valuable issues" [5]. However, Professor Wusheng hasn't intensively examined the standards for case selection in law teaching or brought forth a systematic standard for case selection. Professor Gongyun and Doctor Gairong of the Law School, East China University of Political Science and Law have pointed out some notes that should be paid attention to during case selection. In actuality, they have proposed that "selected cases must be true and representative" [6]. Professor Sarah Cleveland (Columbia University, U.S.) has made his point on selecting of casebook that: "a good casebook, from whatever perspective of the authors, does make a fair and good faith attempt to provide different perspectives, critiques, and challenges to the perspective of the casebook" [7]. However, these scholars mentioned above haven't discussed about the standards for case selection in depth or established a complete standard for case selection either.

Hence, the author deeply recognizes the importance for establishing a systematic and complete standard for selecting current events for teaching international laws. Based on years of practical experiences in teaching international laws, the author has proposed in the article "On Selection Standards for News on Current Events for Teaching International Laws" (2018) that teachers of international laws are required to collect hot current events before classes and select pertinent, timely, appropriate and extensible cases (hereinafter referred to as "four standards for case selection" [8]. Connotations and functions of four standards for case selection proposed by the author are described as follows in Table 1:

Table 1. Connotations and functions of four standards.

Standard	Title	
	Connotations (specific to teachers)	Functions (favorable for students)
Pertinency	High coincidence with taught knowledge points	Realize basic teaching objectives
Timeliness	High timeliness	Enhance learning interests
Appropriateness	In terms of content: complicated and simple	Improve understanding of knowledge points
	In terms of forms: implicit and explicit	
Expansibility	Internal extensibility: associate the acquired knowledge	Consolidate acquired knowledge points
	External extensibility: thinking extension	Inspire and extend thinking

2 Research Objectives and Procedures

2.1 Research Objectives

To verify if the four standards for selecting current events put forward by the author in the article "On Selection Standards for News on Current Events for Teaching International Laws" (2018) are helpful for improving teaching effects of international laws, this paper intends to carry out two-week practices for teaching International Laws, a major required course for local undergraduates majoring in laws. Two classes are organized a week and each class lasts for 90 min. Hence, four classes are arranged for this teaching experiment altogether. Based on the author's guess about the teaching effects realized by the four standards for case selection, this paper intends to realize two objectives as follows:

1. Test if the four standards put forward by the author are easy to adopt.
2. Test if the four standards for selecting current events are favorable for teaching international laws.

2.2 Research Framework

The research procedures of this study are as follows:

1. Case evaluation. Before each class, 5 current events are selected as cases in accordance with the teaching tasks and evaluate if experts choose each case according to corresponding standards. The higher the consistency, the higher the scores are. At last, rank the cases in order based on their total scores from high to low scores.
2. Test consistency of expert evaluations. Test if evaluation results of cases based on those four standards for case selection are consistent among several teachers of international laws, in order to observe if these standards are feasible and easy to use in routine teaching of international laws.
3. Classify experimental subjects. In this teaching experiment, 99 law majors of two classes who were admitted for undergraduate education in 2017 by the university where the author works as teacher are selected as experimental subjects. 50 students of Class 1 are categorized as experimental group, while 49 students of Class 2 are attributed to the control group.
4. Use cases. In classroom teaching, the teacher designates students in each class to describe cases, analyze problems and put forward solutions.
5. Test students' achievements. To observe the impacts of the selection standards for current events upon teaching effects of international laws, the author intends to test both the experimental group and the control group.

3 Results

3.1 Analysis on Case Sampling

Three experts and scholars who have taught undergraduates international laws in a university of Guangdong Province for more than 5 years are invited by convenience sampling as interviewees in the first procedures of this study.

For each course, 5 pieces of news on current events with teaching value are selected as per the knowledge points to be learnt. On the premise of guaranteeing authenticity of manuscripts, the data are processed in order that cases on teaching of international laws are in accord with teaching content. Next, the three sampled experts score the five current events within 1 to 10 points according to aforementioned four standards, and the consistency of the cases with each standard is evaluated. Each standard is scored from 0 to 10 points. The higher the consistency between the cases and each standard, the higher the scores are. Hence, each case may get 40 points at maximum, and the cases are finally arranged in order dependent upon their scores from the high value to the low one. In this teaching study, four cases are sampled for evaluation, and the three experts evaluate 20 cases altogether. The experts perform their evaluations independently without discussing with each other as to the evaluated content, so as to guarantee reliability of their evaluations.

3.2 Test Results on Consistency of Experts' Evaluations

To observe whether the four selection standards for current events proposed by the author are feasible and easy to use for routine teaching of international laws, it is necessary to test if the evaluation results of the cases based on the designated standards are consistent among several teachers of international laws. In this study, one out of four cases was sampled to test the consistency of evaluation results by random number. In this consistency test, whether 3 experts' scores for 20 objects were consistent was analyzed through a Kendall's W test. As shown in Table 2 on the results of the consistency test, the Kendall's W coefficient of these 3 experts' diagnosis results was 0.06 and p value was 0.07, which was below 0.05. This suggested that evaluation results of these three experts were highly consistent in spite of no communication.

Table 2. Test results on consistency of experts' evaluations.

Total number	Kendall's W	Test statistic	Degree of freedom	Progressive significance
3	0.655	37.312	19	0.07

3.3 Case Allocation

In this teaching experiment, 99 law majors of two classes who were admitted for undergraduate education in 2017 by the university where the author works as teacher are selected as experimental subjects. 50 students of Class 1 are categorized as the experimental group, while 49 students of Class 2 formed a control group. Students of these two classes were taught respectively. To realize the research objective, different teaching cases were allocated to these two groups. The case with the highest total scores was allocated to the experimental group, whereas the one with the lowest score was assigned to the control group. The cases ranking No. 2, 3 and 4 in total scores were abandoned to widen gaps between cases, in order that experimental results of teaching may be presented more evidently.

3.4 Tests of Teaching Effects

To observe effects of the case-based teaching model, both the experimental group and the control group are tested. Both groups are tested with the same examination paper, of which the full marks are 100 points. The examination paper is made up of two parts: Part 1 is about objective test, for which choices are made and account for 50 points. This part focuses on investigating students' mastery of basic concepts and principles. The other part is about subjective test, where there are questions for case analysis and essay questions. With a total score of 50 points, it mainly tests students' abilities to comprehensively analyze the knowledge they have acquired and logical reasoning skills. Scores of the experimental group and the control group are shown in Table 3.

Table 3. Test results of the experimental group and the control group.

Content	Group	
	Experimental group	Control group
Scores from the objective test	35.4	34.9
Scores from the subjective test	38.7	35.5
Total scores	74.1	70.4

Notes: The data on the table are average scores and rounded to one decimal place.

As shown in Table 3, scores of the Experimental Group are consistently higher than those of the Control Group no matter in the objective or subjective test. For the objective test, scores don't differ significantly between the control group and the experimental group, where the latter only outperformed the former by 0.5 points. However, the scores of the experimental group were 3.2 points higher than the control group. Although the slight gap in the scores of the objective test (0.5 points) hardly account for anything, the considerable gap of 3.2 points may not be neglected. It was just because of its definite advantage over the control group in the scores of the objective test, the experimental group got a total score which was 3.7 points higher. In essence, the leading reason consisted in the fact that the case allocated to the experimental group was best in line with the four selection standards for current events proposed by the author.

4 Conclusion

By verifying if the designated four selection standards for current events are easy to adopt and positively impact teaching of international laws through above research procedures in combination with empirical analysis methods such as expert evaluation, consistency test and evaluation of teaching effects, conclusions are reached as follows:

In this study, one out of four evaluations is sampled to test its results by random number in testing consistency of experts' evaluation results. Pursuant to the results of the consistency test, the Kendall's W coefficient of these 3 experts' diagnosis results was 0.06 and p value was 0.07, which was below 0.05. This suggested that evaluation results of these three experts were highly consistent in spite of no communication. It may be inferred from the consistency test results that the four selection standards for current events are feasible and easy to practise, because teachers of international laws may independently conform to these standards during their routine teaching.

The test results reveal that scores of the Experimental Group are consistently higher than those of the Control Group no matter in the objective or subjective test. The author considers that the leading reason consists in the fact that the case allocated to the experimental group was best in line with the four selection standards for current events proposed by the author. Therefore, it may be deduced from the results that it is positive for teaching effects of international laws by conforming to the four standards.

Although this paper only discusses case-based teaching of international laws, in consideration of similarities among specialties of laws, the author considers that the four standards proposed in this paper are also applicable to case-based teaching of other law-related courses. In addition, the empirical methods adopted in this paper may be used as references for other fields other than laws to establish a range of systematic standards for case selection.

Acknowledgement. Foundation items: The authors would like to acknowledge the support of Quality Engineering Project of Guangdong Province of China in 2015: Project of Comprehensive Reform on Specialty of Law in Guangdong University of Petrochemical Technology.

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Augmented Reality to Promote Understanding and Cognizing in Learning of Engineering Drawing

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Abstract. Since augmented reality (AR) technology has the characteristics of enhancing display effect and real interaction with human beings, it has been widely used in different scenarios of education. However, the AR technology usually requires a corresponding equipment such as a head mounted display (HMD) to display, so its application scope is limited in many aspects. This paper uses the Unity development tools to develop an AR application, which can display three-dimensional (3D) structural models corresponding to different three views of a geometric object on mobile smartphones. During the learning process of engineering drawing, different three views can be scanned by the application, and the corresponding 3D model is automatically restored. By combining the virtual 3D structure with the real world experience, students can better learn engineering drawing courses in the virtual combined environment. The survey results show that the AR application can effectively improve students' understanding and cognizing of 3D objects in engineering drawing learning.

Keywords: Augmented reality · Three-dimensional model · Engineering drawing · Mobile application

1 Introduction

With the rapid development of information technology, many researchers pursue better teaching results by combining education with multimedia information technology. Virtual reality (VR) and augmented reality (AR) technologies have been applied to different teaching fields, such as chemistry teaching [1], learning to drive [2], and early childhood literacy teaching [3].

AR technology was developed from VR technology, which was proposed in 1990 and first used for military purposes. Firstly, it simulates the physical information, which is difficult to experience in the real world, in time and space through computer and other scientific technologies. Then the simulated virtual objects and real environment are superimposed to the same picture or space in real time to achieve similar or even beyond the real world sensory experience. Nowadays, AR technology is still in its infancy in China, and most of the researches still focus on the algorithm implementation and optimization. However, many companies in the field of VR have begun to

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 357–366, 2019.
https://doi.org/10.1007/978-3-030-35343-8_38

focus on the development of AR in specific applications. For example, the city lens can superimpose the rich cloud business data on the real scene, bringing multi-sensory navigation experience. It is already a mature smartphone application that aggregates the current mobile Internet AR technology [4, 5].

The understanding of the virtual world mainly depends on human perception of the visual aspect, so 3D stereo vision is the first sensing channel of VR technology. At present, the commonly used display equipment mainly includes HMD, binocular omnidirectional display (BOOM) and so on. HMD is a stereoscopic display device which is commonly used in the VR systems. It is usually mounted on the head and fixed by mechanical means. There is no relative movement between the head and the helmet. Depth perception is achieved by fusing images seen by the left and right eyes, so that a stereoscopic image can be obtained. It completely isolates participants from the outside world and has become an indispensable 3D stereoscopic output device for enhanced VR systems. The position and direction tracking of BOOM is realized by calculating the change of the angle of robot arm node. Therefore, the system delay is small and not affected by the magnetic field and ultrasonic background noise.

Generally, the teaching applications with VR and AR technologies require HMD and other relevant equipment to assist display. The investment expenditure of these hardware devices limits the application of these technologies in teaching scenario. Unluckily, the engineering drawing course for freshman students is very suitable for 3D physics display by using AR technology. To address this problem, this paper mainly models the 3D model corresponding to the different three views in the engineering drawing, and uses the Unity development tool to develop an application that can run on the smartphones. The application can automatically restore the corresponding 3D model by scanning different three views. In addition, the 3D model can be rotated freely for students to observe at different angles. Due to the popularity of smartphones, this AR model can be easily generalized, thus effectively improve students' understanding and cognition of 3D objects.

2 AR Technology and Applications

Due to the following outstanding features, the AR technology system has been designated as the mainstream of international education application research in the recent years.

1. Information integration between the real world and the virtual world.
2. Real-time interactivity.
3. Add and locate the virtual objects in the 3D scale space.

With the development of science and technology in recent years, the AR technology has the characteristics of enhancing display output to the environment and real interaction with human beings. It has a wide range of applications in the field of sophisticated weapons, aircraft development, data model visualization, games and entertainment. Moreover, it has very obvious advantages in the field of primary and secondary schools, higher education and training courses.

2.1 Chemistry Courses

It is well known that the chemistry is a discipline which need to study the composition, structure, and laws of change, and the concepts and principles are relatively abstract. In practical teaching, it is difficult for the students to truly understand the nature of chemical changes simply by relying on the explanation of the teachers and the textual description of the textbook. As early as 1996, Barnea et al. studied that it is possible to help students understand molecular or atomic structures by manipulating physical models [6]. Later, Chen et al. proposed that AR can present dynamic structures that cannot be presented by physical models through the role of real models. By 2014, Cai et al. developed an AR application of "material composition" using image recognition technology [7]. Students can interact with these 3D models by moving molecular or atomic tag cards and then capturing them with a computer camera. They can also see the irregular movement of molecules and atoms and the formation of compounds through animation. Some toxic and harmful experiments are largely limited by environmental conditions, but this situation can also be remedied by AR technology. As shown in Fig. 1. In the most simple and intuitive way, the teaching process of chemistry course becomes more vivid and the knowledge becomes easier to understand [8]. At present, the use of AR technology to make chemical reactions from abstract to specific is already a very mature and effective teaching method.

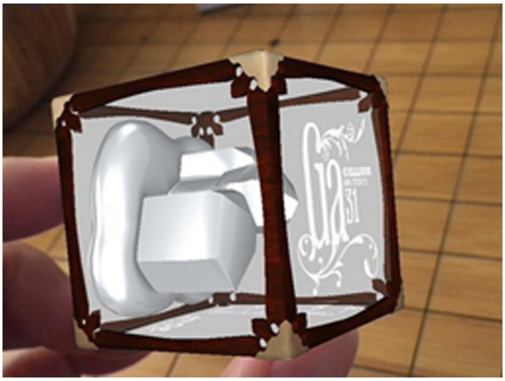

Fig. 1. Model of AR applied to practice in chemistry course.

2.2 Learning to Drive

Driving is a skill that requires repeated training, and not enough training is often enough to learn to drive in a short time. Although driving schools have become more standardized in recent years, train bookings can already be made through online networks, and there is no need to queue up early every day. But overall, the training of newcomers is still seriously inadequate. The rough experience provided by traditional analog driving (simple steering wheel and gearing) keeps it in the industry. Until the advent of realistic VR technology, the simulation analog driving technology has the possibility of changing the industry model. As shown in Fig. 2. When practicing in the field, we can use the external equipment such as the steering wheel to combine the corresponding program software to carry out the train training. As early as 2015, Toyota teamed up with Oculus Rift to launch the TeenDrive365 system. The experiencer can simply sit in the cockpit and wear a VR helmet to simulate the various road conditions that may be encountered during driving. In addition to the realistic sound system, the driver once had a real visual experience. Also at last year's Consumer Electronics Show in Berlin, the Samsung Gear AR combined with the I3 provided the VR test drive experience for the experience. Using VR equipment with related software to help users practice driving is currently perfect. It can be seen that the application of AR technology in the field of analog driving vehicles has been quite mature.

Fig. 2. Students simulate the actual driving scene with AR technology

2.3 Early Childhood Education

With the advancement of technology, AR technology is increasingly being applied to various fields by more people, and the early childhood education market is no exception. As the leader of the education industry, New Oriental has taken the lead in creating an artifact of AR intelligent spelling "Let's Learn Spelling with Dona Fun", which has caused a good response in the market [9]. Other applications for early childhood education, such as "Pocket Animals" and "AR doodle", have also emerged. Unlike general applications, AR preschool software is more focused on the content of the application. The children are guided and inspired mainly by audio and video in the content, and also enhance the children's subjectivity and participation in the learning process.

Compared with the arrangement of lesson preparation and wall display, teachers can pay more attention to the observation and recording of children's activities, and truly become helpers, supporters and observers of early childhood activities. AR technology can create a realistic and vivid teaching situation for young children, and obtain intuitive information through interaction with virtual scenes, thereby improving learning quality and efficiency, and acquiring knowledge and skills. Based on the visualization and interactivity of AR, some products have also designed game teaching content that is very attractive to young children. On the one hand, it adapts to the nature of children's love of play, on the other hand, it also greatly enhances the children's willingness to learn the required content and stimulate their interest in learning. More importantly, the current domestic AR engine platform has broken the situation of the same type of platform in the foreign market, and many representative SDK platforms have emerged. This cannot help but make people look forward to the follow-up development of the AR technology industry, including the early childhood education market [10].

3 AR Application for Engineering Drawing

In this chapter, we mainly research the combination between engineering drawing courses and AR technology. According to the abstract and difficult 3D geometry problem that appears in the engineering drawing teaching, the required teaching information can be displayed on the mobile phone or computer through AR technology. The spatial structure information obtained through the AR technology forms a learning environment which integrates the virtual and reality objects. Students move from passive recipients of information to active discoverers to understand and learn the content of engineering drawings in a more realistic and subjective perspective. First of all, AR technology has the following advantages in teaching applications.

– It breaks the traditional single and passive teaching mode, reduces the burden on teachers and attracts students' attention.
– It makes some abstract content visualized through a 3D enhanced environment.
– The learning environment built by AR technologies is immersive and interactive, which can stimulate students' imagination and creativity through hands-on experience.
– Virtual experimental teaching environment can effectively reduce expensive equipment, thus reduce costs and pollution.

3.1 Background and Development Environment

Combined with the actual situation of current engineering drawing teaching, teachers often use the physical demonstration to help students understand the overall structure of the 3D graphics. However, this method works well for some simple 3D graphics, such as the three views of the circular hammer on the left in Fig. 3. And when we encounter the complex three views in the right picture, it is obviously not advisable to use the physical demonstration method. Because each student has a self-conscious way of thinking, and has a sense of self dimension. On some complex engineering drawings, students who are unreliable on high-level stereo geometry or lack of space imagination are undoubtedly very difficult to understand [11]. With the development of information technology in recent years, the rapid adoption of smart phones by the society provides convenience for anyone to obtain VR and AR [12, 13]. Therefore, we consider whether we can use AR technology to improve this situation, so that the original complex real model and boring teaching content are presented to students in an intuitive and novel way. While reducing the burden on teachers, it can effectively attract students' attention, stimulate students' enthusiasm for active exploration, and improve students' ability to learn independently.

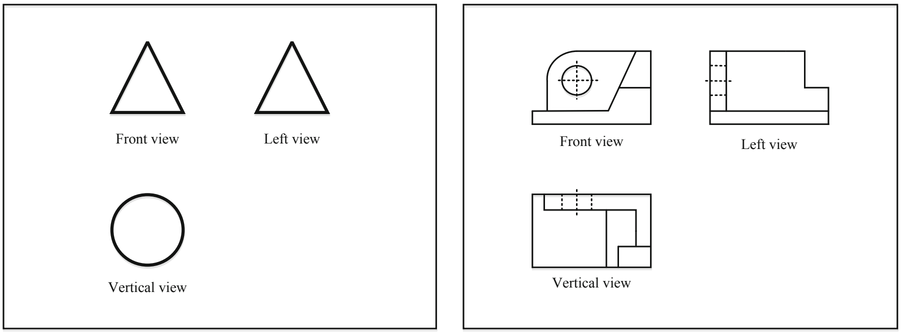

Fig. 3. Three views of the cone and the 3D multi-combination graph

In terms of software development platforms, there are many choices such as HTML, REACT, XAMARIN, Angular 2, and Unity etc. Through comparison, it is found that HTML is a cross-platform for hybrid development, and the user experience is not very good. XAMARIN reacts relatively slow in Android emulator and real machine debugging. REACT and Angular 2 currently only support Android and IOS, and they have the disadvantage of being more restrictive and inflexible. Unity is a development platform with the lowest entry cost, strong versatility, abundant resource market plug-ins and strong cross-platform performance. It can also be compatible with Android, IOS, Windows and Max OS X systems. The most important thing is that unity not only debugs fast but also uses interactive graphical development environment as the primary platform [14, 15]. For example, the famous mobile AR games "pokemon go" and "AR ruler" are developed on the basis of unity 3D. Therefore, unity 3D as is adopted as the development platform for this application. The unity 3D interface is shown in Fig. 4.

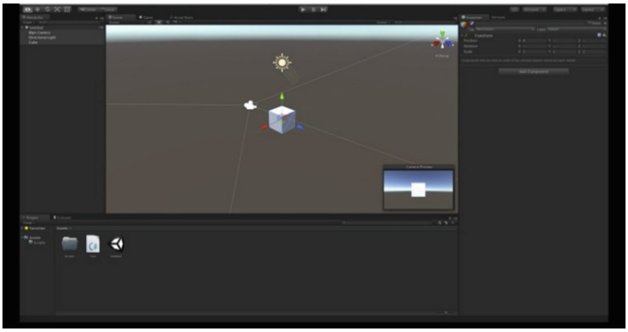

Fig. 4. Unity 3D work interface

3.2 AR Specific Application Operations

VR is to build a completely virtual world through computer 3D imaging technology, and bring the people a completely closed immersive experience. In contrast, AR emphasizes the ability to incorporate computer-generated virtual information into real scenes to achieve real and virtual interactions. It does not cut off the connection between the experiencer and the real world, so AR pays more attention to interactivity. Nowadays, due to the popularity of mobile smartphones, we develop such an application by using AR technology. Students only need to download the application and open it on their phones or tablet computers. By using the camera to collect picture information at the paper with front view, left view and top view, the corresponding 3D spatial model of the three views can be seen on the mobile phone screen. In this way, the original boring and difficult geometric structure can be vividly presented in front of everyone. As shown in Fig. 5. Moreover, students can understand the internal structure of complex 3D graphics directly through the demonstration of AR technology, which is no longer just an armchair strategy as usual, thus greatly improving the learning efficiency [16, 17].

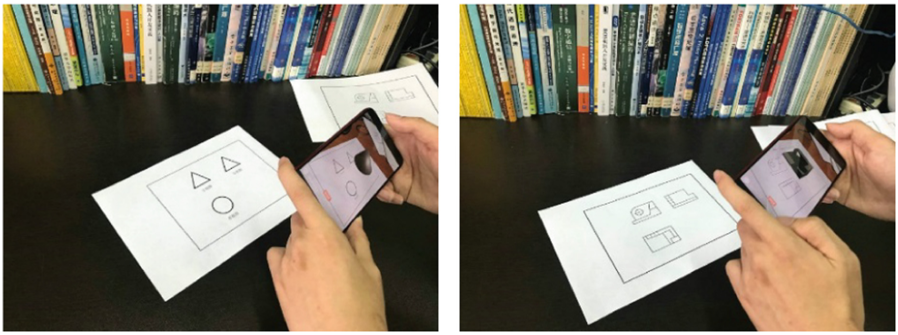

Fig. 5. The user restores the stereo model using the software

With this application, the students of engineering drawing can see the geometric model from 2D three-views to 3D structure restoration. In addition, as shown in Fig. 6, the multi-dimensional rotation of the 3D space model can be clearly seen on the screen of the mobile phone. With the finger swiping the screen, the students can observe the object from different angles. This makes some solid geometry, which is super-complex or occluded at a certain angle of view, easy to be observed. With the use of AR technology, students are in the real world and can still interact directly with teachers. The advantage is that you can use any correct three views, not necessarily pre-defined, with good speed and stability depending on the size and characteristics of the memory library, and this application is easy to learn and master, which is a good choice for inexperienced students.

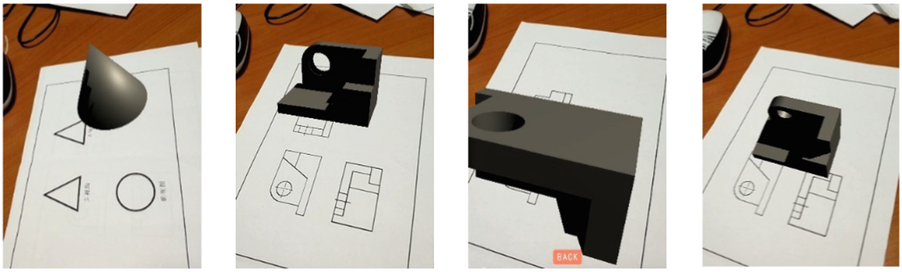

Fig. 6. Multi-angle demonstration of plane three-view to 3D model.

4 Evaluation Results and Prospects

In order to better understand the students' real experience of engineering drawing learning after using AR technology. We randomly selected a hundred students and conducted a satisfaction survey after experiencing this AR application. Through the screens of the mobile phones, one hundred students can clearly see the internal space from the plane three views to the 3D geometry. The results of the student satisfaction survey are shown in Table 1. Among them, 82% students were very satisfied with the overall comprehensive experience. They said that the technology greatly improved their recognition of the learning process of the course and stimulated their unprecedented interest in learning. Some of them said that they could not even imagine the 3D geometry of the interior space can be observed at 360°, and cannot help but marvel at the great technology. Of course, there are also a few students with high spatial imagination who say that this technology is not particularly effective for them, but the existence of such technology will greatly enhance their curiosity and enthusiasm for scientific and technological exploration.

Table 1. Percentage survey of student satisfaction

	In improving learning interest	In deepening understanding	In learning effectiveness	Comprehensive experience
Very satisfied	75%	82%	73%	86%
General	13%	12%	16%	8%
Not satisfied	12%	6%	11%	6%

There is no doubt that it is feasible to extend AR to other teaching courses, such as geography teaching in high school. In traditional teaching, students can only recognize the knowledge points of atmosphere and thermal circulation by looking at the two-dimensional plan drawn by teachers in textbooks or blackboards. However, using AR technology, a 3D real-time flowing atmosphere or world ocean current model can be directly presented to students. Also in the general teaching of biology, VR technology can be used to construct some complex and abstract biological structure models. For example, the composition of the molecule, the double helix structure of the DNA, and the pairing of the four bases are vividly presented to the students. In general, VR technology is conducive to breaking the constraints of teaching in time and space in the teaching of more courses. This will undoubtedly lead to major changes in the interrelationship between the environment, form and process of education.

5 Conclusion

AR technology can integrate virtual information into real environment, such as objects, pictures, videos, sounds, etc. The application of its technology can create a multi-dimensional environment space similar to the real society, and it is easier to solve the situational and interactive needs in the teaching of engineering drawing. AR technology aims to provide a variety of auxiliary information for human beings, making the physical world more closely connected with the information world. It has become an important hub for communication between humans and the information world. For all colleges and universities, it is not difficult to introduce AR technology into the teaching system under the background of constant promotion of information-based teaching. Adding AR technology to the classroom teaching is not only the advancement of technology, but also the transformation of classroom teaching methods. It is believed that in the future, AR technology will integrate more real-world material content and build a more comprehensive and better world.

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Student Performance Evaluation Based on Online Discussion

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Abstract. Nowadays, it is no longer appropriate to evaluate students' performance just only using the final exam scores, the learning procedure should be taken into account as the compensation. Online discussion is widely employed and is one important component in blend learning. Combining participation and the depth of thinking, we propose a model to evaluate students' performance in online discussion as a compensation for the final evaluation. Further on, we examine the key factors that affect the discussion performance. The result reveals that with/without the instructor's participation, the questions level and the form to initial a question affect the students' behavior pattern and discussion performance, and more, besides of instructors, those "Discussion Leader" who are active in discussion and always give deep level posts have the same effect as the instructors on the discussion.

Keywords: Evaluation · Online discussion · Student performance

1 Introduction

Nowadays, more and more people think it is unreasonable to simply evaluate the performance of students based on just the final exam score, because education is never a process in which students read and then finish exam question. Encourage students to actively study, think independently, cultivate students' ability and awareness of deep thinking, and let students build a mature cognitive system is the goal that education has been pursuing. The discussion between teachers and students, students and students during the learning process is a way to exercise students' thinking and express ability.

With the popularity of online learning in recent years, online learning, a convenient learning way that ignores time and space constraints, has been recognized by teachers and students. Compared to the discussion in the traditional classroom, the online discussion is more popular among students. So, can we design a way to more reasonably evaluate a student's performance in the course by analyzing the enthusiasm of students during online discussion and the depth of thinking in the discussion process? Through this new method, can we analyze what factors influence the thinking depth of students in the discussion process?

In order to solve the questions above, we selected a course to carry out the research. We set up an online discussion in this course, and students' performance in discussion

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 367–375, 2019.
https://doi.org/10.1007/978-3-030-35343-8_39

would be used to calculate the final score and it would account for a large proportion, so one or two questions would be arranged after each class for students to discuss online. Based on the data collected, we analyzed the main factors that might affect learning performance. The main contributions of this paper include two aspects. First, we propose a new learning performance evaluation model. Second, inspired by the thinking level, we propose an evaluation standard of students' thinking depth in discussion, and analyze the interaction data to get the key factors affecting it.

The rest of this article is organized as follows. Section 2 is related work. Section 3 is experiment design. Section 4 is result and analyze, we analyze the main factors that affect students' performance. Section 5 summarizes the paper and briefly describes the future research ideas and experimental directions.

2 Related Work

With the popularity of online learning, researchers have proposed many assessment and evaluation for online discussion, which is an important part of online learning. Liu [3] examine the effect of online assessment training with group discussion in his study, Liu found that the quality of student counter-offer letters improved after online assessment training. Taylor [4] proposed a method to assess contribution of students' discussion activities. Taylor mentioned that many important learning experiences were not assessed because of difficulty, and the key learning outcomes which this assessed activity addresses, in addition to learning more about the topic, are to develop skills in reflective practice, critical evaluation and leadership. Rocco [2] proposed two forms of measurement: those assessing the learner during a lesson and those judging whether a student has met the objectives at the end of the lesson.

Based on the evaluation and assessment, the pattern analysis of online discussion has garnered many attentions. Duraira [6] study employs Wise et al.,'s (2012) patterns of listening behavior to explore the students' interaction level in an online forum platform. Duraira K used cluster analysis method, and indicated four types of listening behaviors with the result. Based on these analyses, some strengths and potential weaknesses in the discussion forum were identified [6]. Hou [5, 7, 8] integrated two analytical approaches to explore and visualize the content and pattern of participants' online project learning discussion behaviors, after the learners' limitations were indicated by result, the limitations were in-depth discussed and suggestions for teachers and educational software developers were also proposed in the literature [7]. In Hou's other two literature, one of them employed lag sequential analysis to empirically explore learners' behavioral patterns in a concept map-based online discussion environment [5], the other combined lag-sequential analysis and quantitative content analysis to further understand the sequential pattern of students' problem-solving discussion behaviors and knowledge-construction levels [8].

Learning from these literatures, and based on the study we have done before [1], we propose a user behavior oriented evaluation model, which consists of two dimensions: participation and thinking level. Then we analyze the difference between different situation, such as whether teachers participate, different problem level and whether "Discussion Leader" participate.

3 Experiment Design

Our intention is to find a way to comprehensively evaluate students' performance during learning as a compensation for the final evaluation. Since online discussion is widely employed and is one important component in blend learning, we selected online forum discussion as our target. We hoped that more students would participate more actively in the discussion, think more independently and deeper during the discussion, and help them to build their own unique knowledge cognition system. In short, we hoped to comprehensively evaluate students' learning performance with the enthusiasm of students and the changes of thinking depth in the discussion process.

Teacher would ask one or two questions related to the course after each class. Except for a few face-to-face discussions in the classroom, most of the discussions took place in our online forum. Students participated on their own after the weekly course.

To examine how the questions level and the form to initial a question affect the students' behavior patterns and discussion performance, the questions were designed in three levels with different forms, shown as Table 1.

Table 1. Question level and example.

Question level	Type	Example
1	Questions about definition, No other information besides the question itself	What is Bayesian decision?
2	Questions about the reason, method and so on	How to pruning decision tree? Why do we pruning decision tree?
3	Open question without standard answer	According to your own understanding, talk about the differences and connections between clustering and classification

In order to calculate the enthusiasm of the students, define the number of times the student speaks N; Sum is the sum of the lengths of all the discussion of a student in the forum; Ave is the average length of each student's discussion, i.e. $Ave = Sum/N$; Max is the maximum length of a single discussion for a student, and Min is the minimum length of a single discussion for a student, $Mid = (Max + Min)/2$. Based on the previous definition, define the average discussion correction L_{A-M}, total discussion correction L_S, and discussion activity A, their calculation formula is as follows.

$$L_{A-M} = Ave - Mid \quad (1)$$

$$L_S = Sum * \left(1 + \frac{L_{A-M}}{Max}\right) \quad (2)$$

$$A = \frac{L_S - \min L_S}{\max L_S - \min L_S} * 60 + 40 \quad (3)$$

It is worth noting that although from the calculation formula of A, A will not be lower than 40. But if you didn't participate in the online discussion, A will not be calculated by the formula but directly taken as 0.

In terms of the thinking depth of the discussion, each online discussion record is scored according to Table 2. Scoring will be done by the teachers.

Table 2. Thinking depth score standard.

Score	Standard
1	Not directly related to the current theme or there is copy plagiarism Dialogue or discussion without answering the nature of the question
2	Related to the theme, no independent thinking
3	Related to the theme, a certain general thinking Have their own opinions, but the opinions are not accurate enough or the ideas are not clear enough
4	Related to the theme, deep thinking Can answer question with own opinion and language

After scoring each discussion, the total score T_S and average score T_A of each student were counted. Define the thinking depth parameter T as

$$T = T_A * (N - N_0) = T_S - N_0 * T_A \tag{4}$$

Since we set up 5 discussions, N_0 is set to 5 in the formula (4), that is $T = T_S - 5T_A$. The value of T will increase as T_S and N become larger, which is in line with our requirements for students to discuss more deeply and more frequently. By observing the value of T, it is possible to visually see the student's situation in terms of the number of discussions and the depth of thinking.

Define the score of the final exam is S, then the algorithm for calculating the participation learning performance P is as follows:

$$P = A * 50\% + (T + S) * 50\% \tag{5}$$

4 Results and Analyze

As mentioned above, we suppose that students who are active in discussion and think deeply will have good performance, which means the model will give a high performance score. This section analyzes the results and explore the key factors that affect the performance.

4.1 Data Statement

We obtained data from the online forum of class Machine Learning at Central China Normal University, Spring 2019. There were a total of 63 students and 3 teachers participated in the discussion, a total of 370 discussions which 322 from students and 48 from teachers. Each discussion data contains fields such as date, time, ID and name of speaker, content of discussion, etc.

4.2 Relation Between *A*, *T* and *S*

As Formula (5) stated, performance score P and final exam score S is positive correlation. So what we are concerned about is the relationship between A, T and S, shown as Fig. 1.

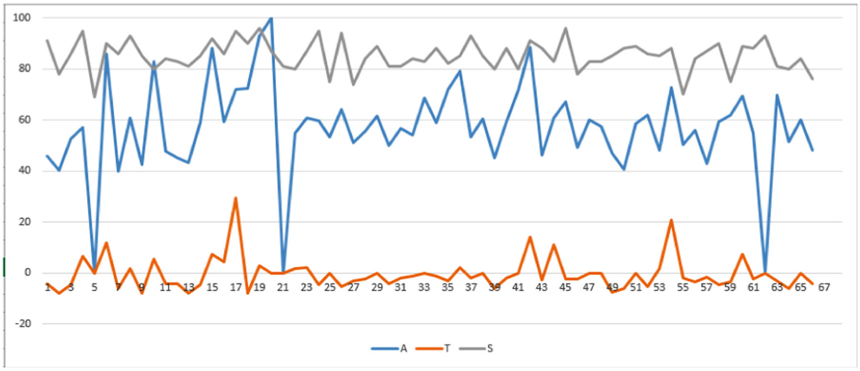

Fig. 1. The value of *A*, *T* and *S*.

We can see that the trend of the A curve and the T curve are roughly the same except from some special example. The students with ID 5 and 21 did not participate online discussion, and their final exam score S did not reach the average score. But student with ID 62 did not participate as well, he still gets a high exam score. That means maybe there are still some error in the evaluation model. For some special students, the model cannot achieve high evaluation accuracy.

4.3 The Effects of Other Factors

We choose four topics' discussion data to analyze in four continuous weeks.

For each topic, we divide students' discussions by 15 min. For example, the first discussion from student in Topic1 was posted at 14:59:45, so we put it into period 1, the time period from 14:45 to 15:00, those discussions posted from 15:00 to 15:15 will be put into period 2.

If we consider the discussions in the same period are the discussions from "someone", then we can use formula (3) (4) to calculate A and T in this period. By calculating A and T for each period, we can find out the intensity of the discussion and

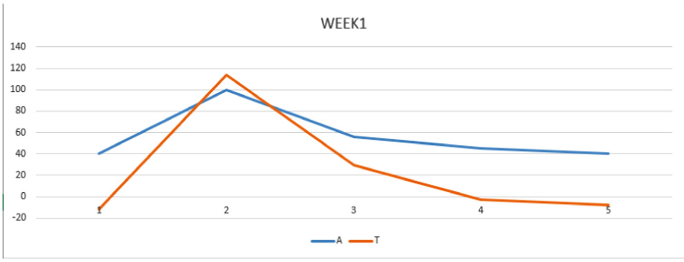

Fig. 2. The value of A&T in Topic1

students' thinking depth's changing pattern in one week. Since different weeks have different situation, we can find out the factor effecting performance by comparing the changing pattern of A and T from different weeks (Table 3).

Table 3. Introduction of questions' topic.

Topic	Week	Period number	Discussion number	Question type	Whether teacher participate	Whether "Discussion Leader" present
1	1	5	77	Definitions/Attributes	No	No
2	2	30	74	Reasons/Methods	Yes	No
3	3	12	67	Reasons/Methods	No	No
4	4	10	103	Open questions without standard answer	No	Yes

In Topic1, teachers did not discuss with students, and teacher's questions were definition question, it is easy for students to find standard answer on book or somewhere else without deep thinking. So, after a peak in period 2, the value of A and T reduced rapidly. There were only 5 periods in Topic1, which means discussion in Topic1 only lasted for about 1 h.

In this topic, the discussion lasted intermittently for a few days, so the last few time periods may not be continuous (Fig. 3).

Compared Fig. 1 with Fig. 2, we can find that the value of A and T reduced by time just like the situation in Topic1. But in Topic2, teachers joined the online discussion and had discussed with student a lot. The teacher's first message was posted at 11:32:53 in period 6. Before period 6, the value of A and T had begun reduced, but in period 7 and 8, it picked up a little bit. In period 9, 13, 14, 22, the value became 0 because no one speaks. And since no one speaked for half an hour, discussion in Topic2 should stop after period 14, but because of the new message from the teacher, discussion restarted in period 15, and it had lasted for a very long time compared to Topic1. Activity of the discussion in Topic2 is very high and very long lasting.

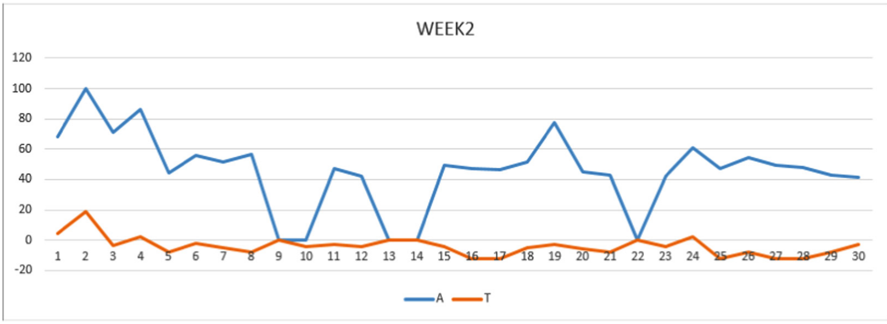

Fig. 3. The value of A&T in Topic2

Compared Fig. 4 with Fig. 2, Topic3's question have high question level and we can find that even the value of A and T became 0 in period 5, it rise from 0 soon, and the discussion lasted for 2 h.

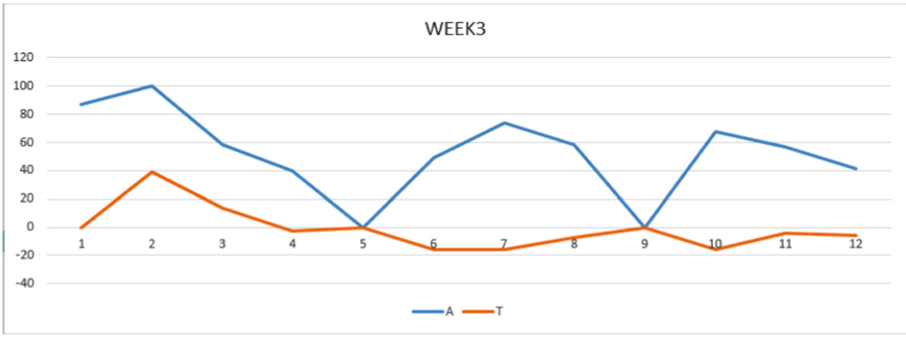

Fig. 4. The value of A&T in Topic3

Compared Fig. 5 with Fig. 2. We can find a very interesting phenomenon this topic. The value of A and T reduced by time as the same, and became 0 in period 3. But after it rise from 0 in period 4, it began to stabilize after rising first and then falling. Compared to Topic2 and Topic3, every time after the value of A rise from 0, the value of T will always be negative before it became 0 again, but in Topic4, the value of T became positive. And in this week, teachers did not join the discussion, the rise of value in period 4 was because of the new message from a student.

Since the changing pattern of the value of A and T is different from Topic2 (which is caused by teacher) and Topic3 (which is caused by question level), we define the student sending new message in period 6 as "Discussion Leader". Discussion leader is not necessarily present, but it can also arouse the enthusiasm of students for discussion and students' thinking depth just like the teacher.

According to the above analysis, we can suggest that teachers' guides and participations are still very important. First, whether the teacher participates in the discussion

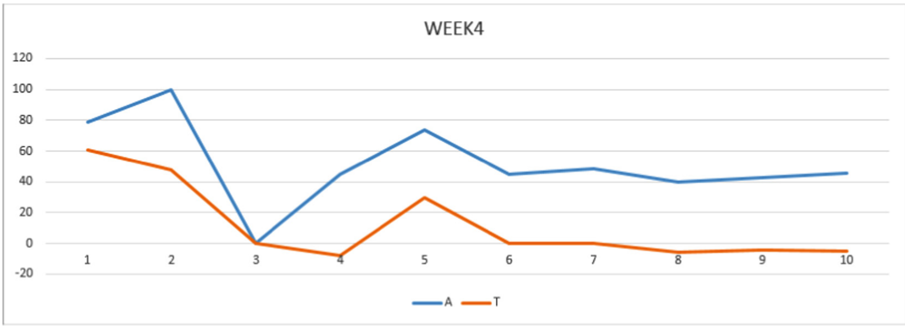

Fig. 5. The value of A&T in Topic4

will directly affect the time of the discussion and activity of the student, the more teacher discusses with student, the more active student is and the deeper student thinks. Second, the question level will affect the thinking depth of student. In Topic2 and Topic3 with level 2 question, after most student had finished discussion, there were still some students who were thinking deeply and discussed with their opinion, such as the period 16, 17 in Topic2 and the period 6, 7 in Topic3 (The value of T became positive is just because there were no more than 5 discussions in this period). Third, it might have some "Discussion Leader" in students, they can arouse the enthusiasm of students for discussion and students' thinking depth. And after their discussions, the pattern of students' discussions and changes of thinking depth is different from that caused by teachers.

5 Conclusion and Future Work

Online discussion is easier to collect students' performance in this process than traditional teaching discussions, and it is easier for us to observe students' performance and changes of thinking depth in the process. In actual teaching, regardless of whether students participate in online discussions, we are more inclined to recognize the efforts students paid in learning for acquiring knowledge and using them rather than just the scores on the paper. This paper develops a method for student performance evaluation that does not rely solely on the final exam scores. It combines the enthusiasm for students to discuss and the quality of the discussion to evaluate the student performance in conjunction with the final exam scores.

It is true that some students do not like the form of online discussion. They rarely participate in online discussions and have achieved better final exam results. However, from the overall results, this evaluation method is a good way to put students' performance and final exams. The performances are merged together, and the contradiction between the number of discussions and the quality of discussions is also solved to some extent. From the results of the model evaluation, the performance scores of the students in different situations, the factors affecting the scores, the influence of the teachers' questioning methods and guiding methods, and the concept of "speaking leaders" in the discussion were analyzed.

Based on the data collected from online forums, our research shows that the difficulty, openness, and whether teachers participate in the discussion when the teacher asks questions will directly affect the enthusiasm and depth of thinking of the students. And with the guidance of the teacher and the advancement of the study time, there will also be "speaking leaders" among the students who will stimulate a wide range of discussions and cause others to think deeply.

In the future research, it is possible to improve the reliability of the model evaluation results by automatically evaluating the depth of the students' discussion and using machine learning to classify the students and further analysis. Further research is being carried out in the areas of automatic evaluation and learning participation learning.

Acknowledgment. This paper was supported by National Natural Science Foundation of China (NSFC) (No. 61807013), and Fundamental Research Funds for the Central Universities (CCNU19QN038).

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Building a Simulated Test Activity to Facilitate Online Assessment of IoT Security: A Case Study of IP Camera

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Abstract. The assessment of the Internet of Things (IoT) security is not easy because it consists of not only conceptual knowledge but also procedural knowledge, and can be regarded as the hands-on assessment. Therefore, in this study, a scheme of Online Simulated Test Activity (OSTA) is proposed to facilitate the online assessment of IoT security. An assessment activity built based on OSTA scheme is able to allow students to virtually operate and interact with the simulated IoT Security scenario, i.e., IP Camera Security, and to offer them the diagnostic reports after the assessment. Accordingly, the assessment performance in IoT Security subject can thus be expected to be improved.

Keywords: IoT security · Hands-on assessment · Simulated test · IP Camera

1 Introduction

With the development of the information and network technology, the network applications become an important part in the human daily life. Moreover, the Internet of Things (IoT) [1], a system of interrelated computing devices with unique identifiers (UIDs) with the ability of transferring data over a network, have also been applied to many domains, such as home life applications and industrial control systems. Therefore, the issue of Network Security [2] has also been paid much attention because it will cause a lot of economic loss if the networks were compromised by hackers. Accordingly, how to train and foster students to possess the concepts and skills of the Network Security is an important issue. The network security practice learning can be regarded as the hands-on learning, so it is not only to learn the conceptual knowledge, but also to perform the practical operation and training for learning the procedural knowledge [3]. The approaches of the Network Security subject, Virtual Machine Images and Virtual Laboratory, are useful for teaching and practicing the learning of Network Security subjects. Nevertheless, they are not easy and efficient for the assessment because the assessment portfolio of students cannot be recorded systemically and analyzed automatically.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 376–380, 2019.
https://doi.org/10.1007/978-3-030-35343-8_40

Therefore, in order to assist teachers in efficiently assessing the learning status of students in Network Security, this study proposes a scheme to create the Online Simulated Test Activity for efficiently evaluating the learning outcome of students in an IoT subject, called OSTA scheme. In OSTA scheme, an OSTA-based test activity can be regarded as a sequence, which consists of various types of test content, i.e., (1) Test Item Unit (TIU) denotes the test items for evaluating the relevant concepts of a subject, (2) Interactive Content Unit (ICU) shows the interactive operations and scenario for the hands-on test and operation of the Network Security subject, (3) Command Mode Tasks (CMT) offers the simulated operations of command mode to emulate the command mode operations in Linux OS, and (4) Diagnostic Report Unit (DRU) generates the diagnostic report automatically according the test portfolio of an OSTA-based test activity.

2 Related Works

With the network technology development, the Network Security [2] has become the pressing issue to threat the applications over the Internet. Therefore, how to train and foster the knowledge and skills of students to prevent and address the problems of network security has become main concerns. Consequentially, Open Web Application Security Project (OWASP) [4] focuses on improving the software security and developing the software to promote the knowledge of software security. Nowadays, with the mobile technology development, the Security of Internet of Things (IoT) [1] includes physical device security and network security both, called IoT Security [5], has also been paid much attention. IoT Security aims to protect systems, networks, and data of IoT security attacks and to target four types of vulnerabilities, i.e., (1) Communication attacks, (2) Lifecycle attacks, (3) Attacks on the device software, and (4) Physical attacks [5].

3 Scheme of the Online Simulated Test Activity (OSTA)

In order to efficiently assist teachers and students in evaluating the skills of Network Security in the IOT subject, this work designs and develops a scheme of the Online Simulated Test Activity, called OSTA. Figure 1 illustrates the OSTA scheme and it is designed as a sequence-based learning activity, which consists of the relevant test content for the concept testing, and the hands-on test and practice of Network Security skills. Moreover, the online diagnosis process will analyze the test portfolio to automatically generate the online personalized diagnostic report to assist students in self-reflection.

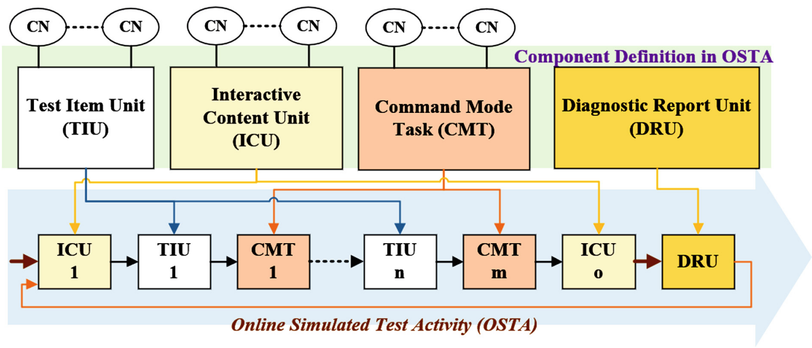


Fig. 1. Scheme of the Online Simulated Test Activity (OSTA).

3.1 The Definition of OSTA

The definition of an Online Simulated Test Activity (OSTA) is as follows:
$\text{OSTA} = \{\text{TIU}_{\text{set}}, \text{ICU}_{\text{set}}, \text{CMT}_{\text{set}}, \text{DRU}\}$, where

- $\text{TIU}_{\text{set}} = (\text{TIU}_1, \text{TIU}_2, \ldots, \text{TIU}_n)$: a set consists of n test item units (TIU_n), each of which includes the test items for evaluating the relevant concepts of a subject.
- $\text{ICU}_{\text{set}} = (\text{ICU}_1, \text{ICU}_2, \ldots, \text{ICU}_o)$: a set consists of o Interactive Content Unit (ICU_o), each of which is used to show the interactive operations and scenario for the hands-on test and operation of the Network Security subject.
- $\text{CMT}_{\text{set}}=(\text{CMT}_1, \text{CMT}_2, \ldots, \text{CMT}_m)$: a set consists of m Command Mode Tasks (CMT_m), each of which is used to show the simulated operations of command mode to emulate the command mode operations in Linux OS.
- DRU: denotes the Diagnostic Report Unit (DRU) generated automatically according the test portfolio of an OSTA-based test activity.
- Each Unit of an OSTA-based test activity except DRU can be associated with the relevant Concept Node (CN) of the concepts in a Network Security subject.

The Test Item Unit (TIU) in OSTA. According to the definition of the OSTA scheme, an OSTA-based test activity is a linear sequence, which consists the relevant test content, each of which denotes the test items (such as single choice and multiple choices questions) for assessing the understanding of the concepts of a subject, especially for the conceptual knowledge.

The Interactive Content Unit (ICU) in OSTA. The ICU can be created by teachers and allows that students visually and virtually hands-on operate and interact with it. Accordingly, the ICU can be used to design and enrich the OSTA-based test activity to create a scenario-based test activity to meet the context of a Network Security subject. Furthermore, each of ICU is also able to be defined with the associated CN for the automatic diagnosis in the process of Diagnostic Report Unit (DRU). In order to facilitate the construction of the ICU, the context and content of ICU are able to be created by means of our previous work, Collaborative Diagnostic Virtual Experiment System (CoDiVE) [6]. It offers a Visualized Reusable Object-based Construction

Scheme (VROCS) based on Object-Oriented Design Approach (OODA) and Rule-Based Control Approach (RBCA) to enhance the Reusability and Extensibility. In CoDiVE system, a Web-based visualized authoring tool, as a WYSIWYG style, has been developed to facilitate the construction of the Diagnostic Virtual Experiment (DiVE) by defining the associated attributes, actions, and control rules using the drop-down menu and be presented by 2D graphics and HTML5. Therefore, non-technical teachers can easily create the desired DiVE-based ICU without the programming for addressing the high cost issue of ICU construction.

The Command Mode Task (CMT) in OSTA. In a test context of a Network Security subject, the operations of a command mode in Linux OS are necessary. For example, type the correct the instruction in command mode of Linux OS for finding the loophole, such as "grep -r "telnet"". However, it is not easy and time-consuming to build a real environment for the assessment, even though the usage of the virtual image file. Therefore, in an OSTA-based test activity, the CMT is designed and used for the emulation of the operations of the command mode in Linux OS. Like the ICU, a CMT can be created by the CoDiVE system [6] and integrated with a special-purpose system to deal with the process and feedback of the instructions of a Network Security subject. Similar as ICU, CMT is also used particularly for the assessment of the procedural knowledge.

The Diagnostic Report Unit (DRU) in OSTA. The testing behavior and portfolio of the OSTA-based test activity can be recorded and analyzed to automatically generate the Diagnostic Report Unit (DRU) for the self-reflection after the assessment. The DRU will provide students with the status of the assessment, including the score of the whole test activity, the degree of the CNs, and the status of each step in the simulated test activity. Accordingly, students and teachers can immediately understand the testing status and learning barriers according to the Diagnostic Report Unit after the finish of the online assessment.

4 Implementation

In order to show the workability of the proposed OSTA scheme, an OSTA-based Test Activity in IP Camera has been built to online simulate the virtual operation and testing by means of the browser. Figure 2 show its procedure, which consists of 4 sub-activities, each of which includes ICU, TIU, CMT, and DRU to realize the simulation of a IP Camera topic in the IOT security subject. For example, the sub-activity 3 offers students the virtually interactive operations using the ICU 3 (Fig. 3c), emulates the Linux-like command mode for the hands-on testing using the CMT 2 (Fig. 3b), and uses the test items for assessing the concepts of students using the TIU 3. Finally, the beginning and ending of scenario with the interactive and animated effects can be shown using the ICU 1 (Fig. 3a) and ICU 4, respectively, and the personalized diagnostic report will be given using the DRU.

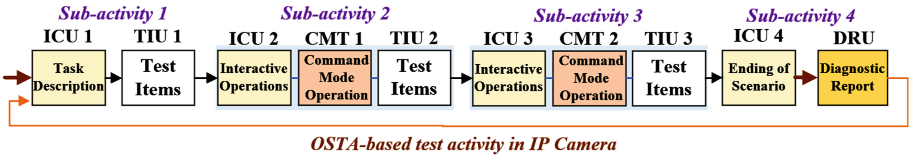
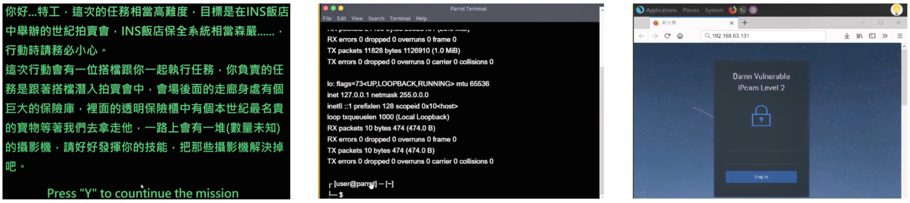


Fig. 2. The procedure of the OSTA-based test activity in IP Camera.



(a) ICU 1 (b) CMT 2 (c) ICU 3

Fig. 3. The screenshots of the ICU 1, CMT 1, and ICU 3 in Fig. 2.

5 Conclusion

In this study, a scheme of an Online Simulated Test Activity, called OSTA, is designed and developed to realize the online simulation and assessment in the IoT Security, i.e., IP Camera Security. Therefore, an online test activity based on the OSTA scheme has also been created to show and evaluate the workability of the proposed OSTA scheme. In the near future, the OSTA-based test activity is going to be applied to the actual class assessment for the evaluation.

Acknowledgement. This research was supported by Ministry of Science and Technology of Republic of China under the number of MOST 106-2511-S-024-002-MY3 and MOST 106-2511-S-468-002-MY3.

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AutoThinking: An Adaptive Computational Thinking Game

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Abstract. Computational thinking (CT) is gaining recognition as an important skill set for students, both in computer science and other disciplines. Digital computer games have proven to be attractive and engaging for fostering CT. Even though there are a number of promising studies of games that teach CT, most of these do not consider whether students are learning CT skills or adapt to individual players' needs. Instead, they boost theoretical knowledge and promote student motivation in CT by usually following a computer-assisted instruction concept that is predefined and rigid, offering no adaptability to each student. To overcome such problems, by benefiting from a probabilistic model that deals with uncertainty, Bayesian Network (BN), we propose an adaptive CT game called AutoThinking. It seeks to engage players through personalized and fun game play while offering timely visualized hints, feedback, and tutorials which cues players to learn skills and concepts tailored to their abilities. The application of BN to AutoThinking not only adaptively provides multiple descriptions of learning materials (by offering adaptive textual, graphical, and video tutorials), similar to the natural way that teachers use in classrooms, but also creatively integrates adaptivity within gameplay by directing the cats (non-player characters) to a specific zone on the game according to players' ability. Consequently, these adaptive features enable AutoThinking to engage players in an individually tailored gameplay and instill CT concepts and skills.

Keywords: Adaptive educational game · Computational thinking · Bayesian network · Timely visualized feedback · Adaptive tutorials

1 Introduction

Computational thinking (CT), first coined by Wing [1], involves "solving problems, designing systems, and understanding human behavior by drawing on the concepts fundamental to computer science" (p. 33). CT thus denotes not programming skills but problem-solving by way of computing, and is defined in the field as a problem-solving process involving logical organization and analysis, abstraction, generalization, decomposition, algorithmic thinking, and debugging [2]—a useful framework for K-12 educators in developing CT activities. Such skills help many daily activities which use information technology to be done more efficiently. However, a key challenge in

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 381–391, 2019.
https://doi.org/10.1007/978-3-030-35343-8_41

promoting CT skills is the lack of opportunities to improve one's CT skills. Various methods have been deployed to make CT more accessible, including programming (e.g., Logo) for projects such as simulations and robots [3, 4]. Other studies use current visual programming tools that rely on game design principles to simplify a programming language down to drag-and-drop interactions. For example, Scratch teaches basic programming constructs to students by cleverly removing the syntax of a programming language and presenting a simple interface through drag-and-drop interactions [5]. Nevertheless, programming tools cannot be counted as games, since they usually lack timely feedback, encouraging engagement, improving retention, and incentives built into good educational games [6]. Moreover, such tools fall short when it comes to fostering deeper learning [7]. There are a number of promising studies of games that teach programming and CT (e.g. [8]), but most of these neither consider the acquisition of CT skills (they rather promote abstract and conceptual knowledge while encouraging student motivation in computer programming subjects) nor offer adaptivity to each player. Instead, they boost theoretical knowledge and promote student motivation in computer programming. While serious games can indeed aid theoretical knowledge, these approaches do not offer learners a chance to solidify or develop their skills (e.g., [9]). We must thus distinguish between games that teach or reinforce theoretical knowledge, and games that teach applied knowledge and develop skills. For the former, the relationship between game and knowledge gained can be purely abstract, but the latter is intricately involved with the functions of in-game play. Extant CT games, meanwhile, generally follow a prefixed and unadaptable computer-assisted instruction concept, despite several recent calls urging researchers, practitioners, and developers to pay more attention to strong personalization and adaptation to the individual needs and preferences in order to explore the full educational potential of computer games (e.g., [10–13]). We must thus create adaptive CT games that engage users with individually tailored gameplay and thereby instill CT concepts and skills.

2 AutoThinking

AutoThinking[1] is an (intelligent) adaptive CT game that we have recently developed for primary and secondary school students that uses icons rather than text, code, or programming commands, thereby reducing the cognitive load by excluding the chances of syntactical errors. It has been developed using Python and is one of the few existing intelligent CT game in the academic world, to the best of our knowledge, if not the only one. Uniquely, it teaches three central CT concepts (sequence, conditional, and loop) and four skills (problem identification and decomposition, algorithm building, debugging, and simulation), see [6], within an adaptive environment shown in Fig. 1. Inspired by Pac-Man—an all-time popular and challenging digital game—AutoThinking seeks to promote CT skills and concepts through fun and personalized gameplay within a large state space. Its design reflects the fact that CT skills of debugging and distributed computation are natural to digital board games [14], and thus

[1] https://youtu.be/O3K6G0i1jYU.

promotes the typical CT transfer of implicit knowledge about game rules into formal logic. Needless to mention that its current design also promotes better spatial reasoning ability of players as it is categorized as board games [15]. The current design of AutoThinking can also expand to future levels of difficulty through randomization and probability. AutoThinking requires players to develop strategies for moving a mouse through a maze while eating cheese, escaping cats, and collecting points. Gameplay ends when all the cheese is consumed or time expires. Table 1 illustrates how AutoThinking promotes CT skills, whereas Table 2 shows how it improves CT concepts.

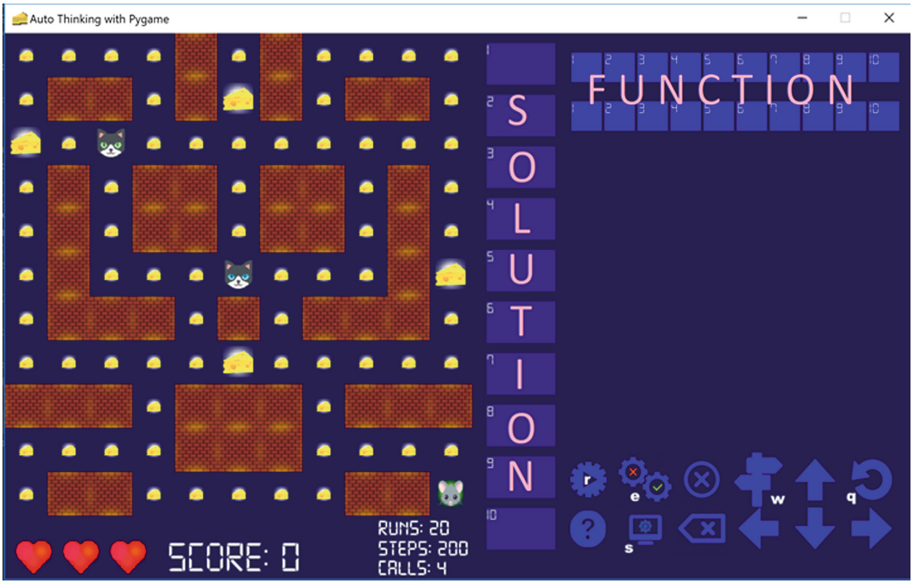

Fig. 1. Interface of AutoThinking.

Table 1. Game activities associated with various categories of CT skills.

Task	CT skill category	Game activity
Problem identification and decomposition	Problem solving (algorithmic thinking)	Help the mouse to eat all cheeses while escaping the cats and collecting as many as points possible on its way AutoThinking provides real-time adaptive interventions to support this skill (offering feedbacks, hints, and tutorials in various forms)
Creating efficient and repeatable patterns	Building algorithms (pattern recognition & pattern generalization)	Use functions to create repeatable patterns. Player can develop function (as a rule/strategies) which can be generalized or re-used multiple times AutoThinking provides real-time adaptive interventions to support this skill
Practicing debug-mode	Debugging	Press the debug button to monitor your solution algorithm to detect any potential errors in your logic

(*continued*)

Table 1. (*continued*)

Task	CT skill category	Game activity
Practicing runtime mode	Simulation	Observe the movements of your mouse during the run-time AutoThinking provides players with a real-time option to simulate execution of their solution

Table 2. Game activities associated with various categories of CT concepts.

CT concepts	Definition	Game activity
Sequence	Sequencing characterizes a component of planning involving arranged actions or computer instructions in the order that produces accurate effects AutoThinking provides real-time adaptive interventions to support this concept (offering feedbacks, hints, and tutorials in various forms)	Drag and dropping commands to the Solution Bar and see the execution after hitting Run/Simulation button
Conditional	The ability to make decisions based on certain conditions, supporting the expression of multiple outcomes AutoThinking provides real-time adaptive interventions to support this concept	If there are junctions stop at junction N, else continue going
Loop	Mechanism for running the same sequence multiple times AutoThinking provides real-time adaptive interventions to support this concept	Keep repeating N times, otherwise continue until a wall

2.1 General Rules and Features

Mouse, Cats, and Cheeses. The player (mouse) must avoid randomly and/or intelligently moving cats to eat the cheeses. The green-eyed cat, in all three levels of AutoThinking, moves randomly WITH repetition, according to the commands placed by players in the solution bar (10 vertical empty slots where player can develop their own solution algorithm to move the mouse). However, the blue-eyed cat, in level two of AutoThinking, moves randomly WITHOUT repetition, according to the number of tiles traversed by the mouse. If, for instance, a 3-command solution led to the mouse moving 10 tiles, the green cat would move 3 tiles at random while the blue cat would randomly move 10 tiles without repetition. What's more, the blue-eyed cat, in level three of AutoThinking, moves intelligently with or without repetition, according to both the number of tiles traversed by the mouse and player's skills (it switches between four algorithms based on player's ability). At the same time, all small cheeses and two big cheeses stay fixed until eaten, but two additional big cheeses move at random.

Buttons. Using keyboard or mouse, players can develop their solution. For example, "Q" and "W" represent "loop" and "conditional", respectively; F1-F2 save your solution/strategy in the 10 horizontal empty slots as a “function” that player can recall and re-use the patterns using digit 1–2, while arrow keys indicate directions. Simulation, debug, run, and help buttons also assist players to simulate (while showing two different pointing systems for their solution: technical skills and cheese scores), debug, and run their solution, as well as have additional guidance and information on the game.

Points. Solutions can earn up to 50 points, aside from cheese points, based on tiles travelled and the fittingness of the commands according to the situations. In other words, pointing system is associated with players skills and solutions. Small cheese is worth 10 points, big cheese 500, and being caught by a cat costs a life and -500 points. Moreover, travelling empty path (without cheese) or going to a wall may cause loss of points according to situation of the maze and the suitability of solution.

Simulation. Players are able to simulate their solution by witnessing the mouse’s movements during run-time while both cats remain fixed, which is a mechanism for running the same sequence multiple times.

Debug. AutoThinking uses a probabilistic approach for players’ skill assessments (see Sect. 2.2). This real-time decision making algorithm equips AutoThinking with various interactive and adaptive options to teach debugging skill which has always been pointed out as an essential component of both CT and programming. Thus, players can monitor their solution to detect any potential logic errors through real-time adaptive and interactive hints, feedbacks, and intervention (e.g., tutorials which aim to support debugging skills and other CT skills). It thus encourages students to think critically about their solutions.

Run. Unlike the Debug button which provide players with different real-time adaptive features (to improve their CT skills and concepts) before execution of their solution, Run button offers different real-time adaptive features after execution of their solution, adaptively cuing players to learn skills and concepts according to their abilities. This way, AutoThinking shoots various type of real-time adaptive and interactive hints, feedbacks, and tutorials (different forms: textual, graphical, or video) in different situations to support players in learning CT concepts and skills. By integrating such features into gameplay, AutoThinking prompts players to work with the interventions to realize the game’s learning outcomes.

2.2 Bayesian Network in AutoThinking

In order to adapt gameplay in real time and offer personalized learning according to players’ skills, using Bayesian Network (BN), a continuous non-invasive assessment has been employed. This embedded assessment connects observable game activity with a learning outcome and performs updates to the player model [16], thereby monitoring and advancing learning through adaptive visualized features (e.g., hints, feedbacks, and etc.), and tailor learning tutorials. It also uses the player assessment to bring adaptivity within gameplay by directing the cat (non-player character) to a specific zone on the game according to players’ ability.

Problem Domain Modelling. AutoThinking stores various information within gameplay sessions, such as players' actions (particularly, the commands used to develop a solution), situation on the board (mouse, cats, and cheeses), score, step, life, and several more. We capture these information in the BN model shown in Fig. 3, where the model entails directed acyclic graph (DAG) and a corresponding set of conditional probability distributions (CPDs) [17].

For our purposes, after identification of a set of CT concepts and skills that are internationally approved and taught, e.g. [6], with the aid of a computational thinking expert and a series of informal informative experiments using several students in Estonia, we manually developed the DAG, where each concept and skill is represented by a node in the graph. If knowledge of a concept is a prerequisite for understanding another, we added a directed edge from the former to the latter. For example, to promote in Problem solving skill (which is one of computational thinking skills), one must first understand the concepts of Conditional and Loop, and Pattern skill. These relationships can be modeled as depicted in Fig. 2. Naturally, Fig. 2 depicts a small portion of the entire DAG implemented in AutoThinking presented in Fig. 3.

The next task in development of the BN is to specify a CPD for each node given its parents. For variable ai with parent set Pi, a CPD p(ai|Pi) has the property that for each configuration (instantiation) of the variables in Pi, the sum of the probabilities of ai is 1.0. In Fig. 2, the parent set of the Problem solving S node is {Conditional_C, Loop_C, and Pattern_S}. An example of the corresponding CPD *p(problem solving|loop C, conditional C, pattern S)* is shown in Table 3.

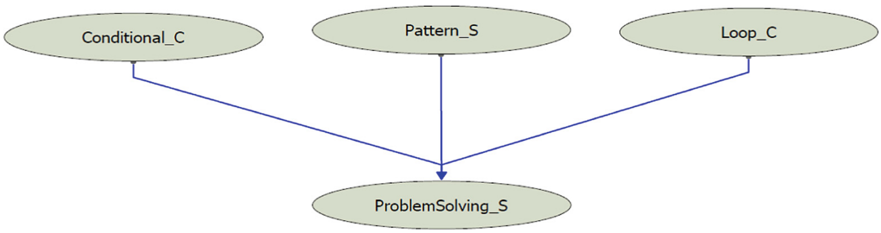

Fig. 2. Sub-DAG for the problem solving skill.

Table 3. The CPD corresponding to the problem solving node in Fig. 2.

Parent nodes			Problem solving	
Conditional C	Pattern S	Loop C	Known	Unknown
Known	Known	Known	0.85	0.15
		Unknown	0.40	0.60
	Unknown	Known	0.55	0.45
		Unknown	0.18	0.82
Unknown	Known	Known	0.40	0.60
		Unknown	0.20	0.80
	Unknown	Known	0.18	0.82
		Unknown	0.10	0.90

Similar to the construction of DAG, we developed CPDs for the DAG with the help of the computational thinking expert and the set of informal experiments. In designing the BN, we did take into account relationship between CT concepts and skills, and all game activities (i.e. suitability of solution built by the player for moving the mouse through the maze while eating cheese, escaping cats, and collecting points – considering random movement of both cats within the large state space, number of existing life, runs, and functions, scores, and etc.). Finally, using the BN model developed for AutoThinking illustrated in Fig. 3, the probability of each concept and the prerequisite concepts (every CPD for the entire Bayesian network) is calculated.

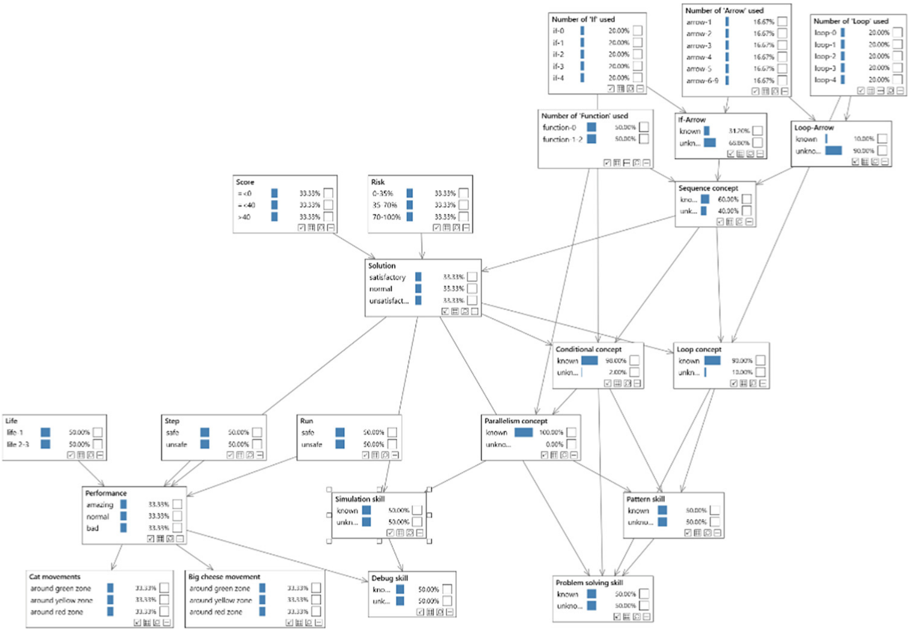

Fig. 3. The entire DAG implemented in AutoThinking.

Parent Nodes in the BN. Nodes "Loop", "If", "Arrow", and "Function" in Fig. 3 represent commands used to develop a solution. The first three have 5 to 6 possible states, while "Function" has two possible states. For instance, states for node "Arrow" include: 1, 2, 3, 4, 5, and 6–9 (denoting probability value of 0.166 to each state) indicating to number of arrow used in a solution. The node "Formula" and "Score" indicate to a solution's risk and possible score for the developed solution; 0–35%, 35–70%, and 70–100% for "Formula" and score = <0, 0<score<40, and score> = 40 for "Score". It is worth noting that even though cats movements are random and unpredictable, in real-time, AutoThinking calculates these two nodes before running a solution (to provide players with adaptive supports for Debugging skills which takes place before running solutions in AutoThinking). To do so, AutoThinking records both mouse and cat movements according to the existing solution through executing the game one level ahead and then using Floyd-Warshall algorithm [18] to calculate and find distance between both cats and mouse. The node “Steps”, “Life”, and “Run”, with two possible states for each, represent number of step, life, and run remained in each time step.

Child Nodes in the BN. Nodes “SequenceC”, ”ConditionalC”, “ParallelismC”, and “LoopC” in Fig. 3 corresponds with the three CT concepts that AutoThinking aims to promote. Node “SequenceC”, for instance, takes into account number of “if”, “loop”, “function”, and “arrow” used in each solution. That said, in a solution that consist of higher number of “loop” or “if” to number of “arrow”, the conditional probability distribution value for node “sequence” indicates that player most likely does not know the concept of “sequence”, since in each solution “if” or “loop” should at least be followed by an “arrow”. This way, the BN model calculates and updates its belief about a player’s CT knowledge about each of the three concepts in real-time. In contrast, node “ConditionalC” takes into account number of “If” used, along with “Solution” and “SequenceC”. This means that the model in real-time update its belief on conditional concept by considering the suitability of “If” used in a solution in accordance to situations on the maze, since “solution” calculates both the risk of a solution and possible points, and as mentioned above, “sequence” considers the suitability of the developed solution (in terms of number of commands used). Rest of the child nodes in the model function this way and are affected according to their parents nodes. It is worth mentioning that according to performance of a player (node “performance” which is influenced by several other variables and factors in the game), the blue-eyed cat will be directed to different situation on the board. Unlike different existing games, in AutoThinking, using nodes “Cats-stay-around”, we take into account players’ skills and knowledge level to direct the non-player character to a specific area of the game (with “red” denoting areas nearby mouse, “yellow” areas not far and not close, and “green” areas very far from current situation of mouse) while it still sometimes moves randomly. This way, the game remain unpredictable and challenging as cat and big cheeses movement are sometimes random but more often in a specific part of the maze based on players’ skills. The justification behind this is the fact that some players may need some provocations (besides the tailored tutorials, hints, and feedbacks) while they underperform or master a concept.

Adaptivity in Learning. Adaptivity in AutoThinking takes place in two different levels in order to explore the full educational potential of our game, before and after running solutions.

Before Run. During developing a solution, players can use “debug” button (before “run” button) to find any possible logical errors in their solution. Accordingly, tailored hints, feedbacks, or tutorials will be presented. This level of adaptivity happens in different forms: (1) the developed solution is “satisfactory” (node “Solution” has the highest probability for state “satisfactory”) according to situations on the maze, collected points, and also the use of various CT concepts and skills by players. In this situation, AutoThinking decides not to intervene and let players continue; (2) the developed solution is “normal”; in this circumstance, AutoThinking offers timely tailored hints and/or feedbacks by highlighting the solution bar and different buttons in the game; (3) the developed solution is “unsatisfactory”; in this circumstance, AutoThinking offers both timely tailored hints and/or feedbacks (e.g., highlighting solution bar and/or button colors), and also graphical/video tutorials related to CT concepts and skills (see Fig. 4).

Fig. 4. Figure in the left shows a solution developed by a player and the one in the right illustrates adaptive visualized hints and feedbacks generated in real-time after clicking on debug button.

After Run. After developing a solution, players can directly “run” the solution (without debugging it) which then triggers tailored hint, feedbacks, or tutorials. This level of adaptivity happens in different forms: (1) the developed solution is “satisfactory”; in this situation AutoThinking decides not to intervene and let players to continue; (2) the developed solution is “normal”; in this situation AutoThinking offers tailored hints, for instance, highlighting the “debug” button in the game to cue players to debug their next solution before running it; (3) the developed solution is “unsatisfactory”; in this situation AutoThinking highlights the “debug” button and also offers tailored textual tutorials related to CT concepts and skills. It should be noted that by shooting various forms of tailored tutorial (graphical and video which takes place before run, and textual which takes place after run) related to different CT concepts and skills in accordance to players level of skills, AutoThinking support multiple description of learning materials, similar to the natural way that teachers use in classroom.

3 Conclusion and Future Work

This paper presents design and development of an adaptive computational thinking game called AutoThinking. Benefiting from a non-invasive assessment which builds and updates a cognitive model of each player, provided by a probabilistic models presented as a Bayesian networks, AutoThinking seeks to engage players through personalized and fun game play while offering timely cognitive pedagogical support, like hints, feedbacks, and tutorials. Such assessment serves a double purpose of: (1) adaptively providing multiple description of learning materials (by offering adaptive textual, graphical, and video tutorials), similar to the natural way that teachers use in classroom, and (2) creatively integrating adaptivity within gameplay by directing the cat (non-player character) to a specific zone on the game according to players' ability. In the near future, we plan to conduct a number of experimental studies using AutoThinking with the aim of investigating its effect on students' learning, and also embed data-driven features to the game according to analysis of collected data from players.

Acknowledgments. This research was partly supported by the European Regional Development Fund through the University of Tartu project ASTRA per ASPERA.

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A Case Study of Taiwan - AI Talent Cultivation Strategies

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Abstract. This study created the "Challenges from the Industry X Solutions from Talents" mechanism, which emphasizes learning from doing instead of traditional talent cultivation modes by aligning artificial intelligence (AI) talents with critical problems of enterprises. The problem-solving process begins with industry AI demands. This paper design a platform, AIGO, aiming to cultivate AI talents, and enabling them to solve real-world industrial problems. The platform is composed of competition, learning and community.

Keywords: Artificial intelligence · Talent cultivation · Industry

1 Introduction

According to the Global AI Talent Report 2019 [1], there is still a shortage of talent, which could be a barrier to the pace of AI transformation [2]. Tsai et al. proposed an innovative hybrid model for developing cross-domain ICT talent [3]. The model adopts 6P-4C training model. Larson et al. used problem-based learning (PBL) to learn foundation engineering knowledge [4]. Mustaffa et al. also integrated PBL with algebraic thinking for school students [5]. Dewey [6] conceived of PBL as a "learn by doing" process so that participants can acquire knowledge related to real-world problems in a gradual way. Gorghiu et al. also revealed that PBL is an efficient learning strategy in science lessons [7]. Based on the researches mentioned above, we adopted PBL-oriented method, to develop AI talent who have skills to solve real-world industrial problems. We collect real-world industrial problems and hold competitions through AIGO.

2 Dual-Track Training Mechanism

To close the gap between schools and industries, a real-time, theoretical-practical cross-learning model can expose learners to real-world industry problems.

The dual-track training mechanism is shown in the following schematic diagram. The industry provides current challenges, and the talents adopts AI smart technologies to solve the industry problems. Participants can also study by selecting relevant in-class training (as shown in Fig. 1).

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 392–397, 2019.
https://doi.org/10.1007/978-3-030-35343-8_42

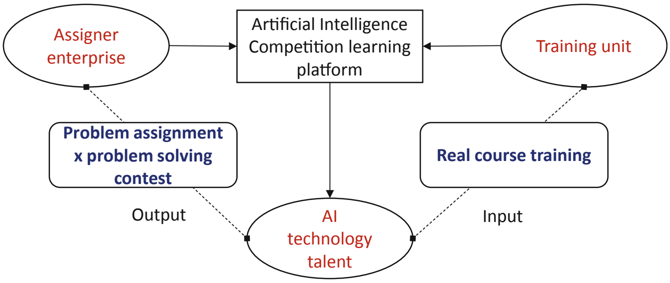

Fig. 1. Dual-track development mechanism

2.1 Challenges from the Industry

This study adopts the "Challenges from the Industry X Solutions from Talents" mechanism to help match problem-solving AI technical talents, thereby facilitating enterprises in the development of AI innovative application services.

Interviews were conducted to assist the service industry to clarify AI or data analysis needs. The rolling correction and content review mechanism is shown in Fig. 2.

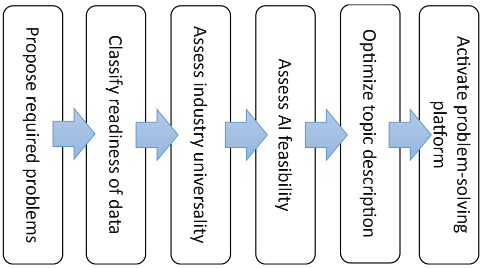

Fig. 2. Industry problem assignment method

2.2 Solutions from Talents

The operation model is shown in Fig. 3. This model explore the integration between AI cutting edge technologies and realistic business scenarios via various academic cooperation, business cooperation, and high-level AI talent training.

3 Platform Architecture

The platform is designed into three blocks as Fig. 4, to realize different purposes. The first block is Competition, the second block is Learning and the third block is Community.

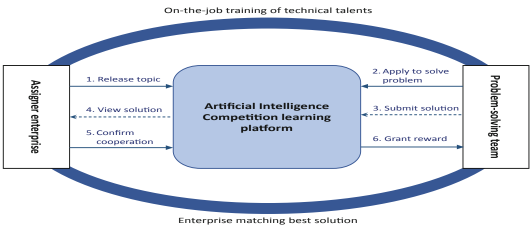

Fig. 3. Problem solving competition mode of operation

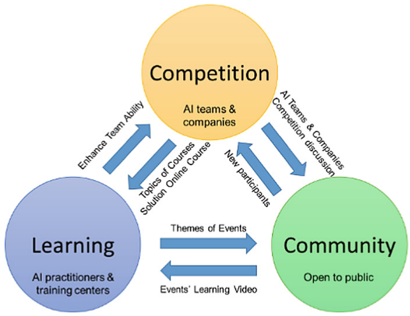

Fig. 4. The structure of the platform and the interaction among them

Competition

Competition is designed according to PBL methods. Teams need to learn how to propose projects, communicate with companies, sign contracts, and other administration services. The competition workflow shown in Fig. 5.

Learning

Learning offers many courses in a diverse range of theory and practical techniques of AI. It also fills PBL's disadvantage, "the gap in knowledge as a result of ignoring structured instruction." [8] .

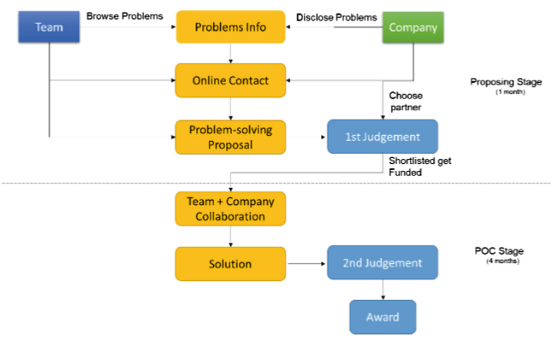

Fig. 5. The competition workflow

There are offline and online courses. We recruit training centers from all around the nation. And the online courses are composed of "Real-world Industrial Series", "Solution Series", "AIGO Events Series" and "Master Lecture Series".

Community
Community offers both online and offline connection towards all the participants of the platform. When we overview the platform, we can see a compound positive feedback loop (shown in Fig. 4) which implies each of the blocks enhances the rest of them.

4 Results

4.1 Challenges from the Industry

A total of 53 questions were collected for this industry topic. According to applications, the topics can be divided into the fields of the Internet of Things (IoT), security monitoring, automobile transportation, financial technology, consumer retail, business services, social media, information services, sports and leisure, and medical and health industries. For the technical classification, the challenges can be divided into five categories as shown in Table 1. The proportion of each category is shown in Fig. 6.

Table 1. Technical classification of industry problem

Technical classification	Number of problems	Proportion
Image recognition category	20	38%
User behavior data analysis/prediction	12	23%
IoT data analysis/prediction	6	11%
Customer service robot/semantic analysis category	9	17%
Others (cybersecurity, data collection)	6	11%

In summary of the aforementioned problem categories, image recognition and user behavioral data analysis and forecast belong to the largest group. The two categories add up to more than 50% of all problems (as shown in Fig. 6) in which, verification sites for image recognition included all industry categories in this study. This shows that AI computer vision applications has started to mature.

4.2 Solutions from Talents

This study matched 43 problem solving teams, as listed in the following figure. The teams consisted of AI startups, Taiwan AI schools, self-organized technology enthusiasts, system integration service providers, schools or research units, totaling 138 people to be trained with practical experience.

Descriptive Statics on the Formation of Problem-Solving Teams
The problem-solving teams were mostly students, alumni, and teaching assistants from Taiwan's AI schools. The participants were interviewed for their motives and actual

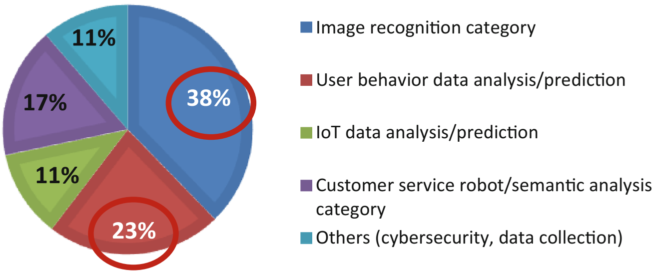

Fig. 6. Proportion of technical fields of problem assigning industries

application fields following traditional AI courses (as shown in Fig. 7). The second largest group is the AI startups team.

	AI newly assembled team	Taiwan AI schools	Self-assembled technical collaborators	System integration service providers	School or research unit
Total	12	14	7	2	8

Fig. 7. Formation of problem-solving team

Industrial Application Analysis of Solved Problems

The problem solving competition of this research produced 21 AI solutions. According to the technical field, 50% were image recognition solutions (as shown in Table 2). According to industry applications, the solutions can be applied to the six major industries of health, information services, consumer retail, human resources, surveillance and security, and IoT.

Table 2. Technical classification of industry problem

Technical classification	Solved problems	Total number of problems	Percentage solved
Image recognition category	10	20	50%
User behavior data analysis/prediction	4	12	33%
IoT data analysis/prediction	2	6	33%
Customer service robot/semantic analysis category	2	9	22%
Others (cybersecurity, data collection)	2	6	33%
Total	20	53	

5 Conclusion

Through themed exchange and matching event such as: image recognition, syntax analysis and other themes, the innovative “Challenges from the Industry X Solutions from Talents” training model guides corporations to convert their demands into a problem, then helps the business owner to propose 53 types of AI application demands.

Awards were given out in the AI service application achievements presentation. The achievements are from the AI demands of various industries. The accumulation of 21 problem-solving solutions that cover 6 major AI application fields.

Taiwan’s AI development strategy report learns from the technology strategic plans and development status of international corporations and summarizes our nation’s AI enterprises as mainly giant ICT corporations and startups. Start from talent, advanced technology, startup incubation, open field and information, and industry application AI environment development.

Acknowledgment. This work is supported through the AI Talent Training Program Project of the Institute for Information Industry, subsidized by the Industrial Development Bureau, Ministry of Economic Affairs of the Republic of China.

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A Case Study of the Impact of Digital Learning on the Quality of Life of People with Disabilities

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Abstract. This study used case study method studying two cases with disabilities. The study starts with surveying the digital application status and digital learning needs of the two cases, followed by designing customized digital learning courses for the two cases, and then assessed the impact of the learning on the cases about their overall life quality. Data collection includes quantitative data (two questionnaires) and qualitative data (course feedback and responses and interview records). The former is analyzed by Excel software, while the latter is analyzed by content analysis. The study found that the customized digital learning courses could help the cases effectively improve their social relationships and breaking the limitations of their learning environment. However, such effect might vary depending upon the individual characteristics and their independence degree of learning.

Keywords: E-learning · Learners with disabilities · Life quality

1 Research Background

Information technology is seen as a tool to help people with disabilities overcome obstacles in learning, living and employment, and even as a tool for empowerment [5]. Digital access is a prerequisite for promoting social participation; digital participation is an important tool for individuals to obtain social resources. As far as the quality of life is concerned, the actual living conditions and personal psychological well-being of people with physical and mental disabilities are closely related to social integration; these related factors include personal development of the disabled, interpersonal relationship such as self-decision and social participation, social integration and individual rights. As well as emotional well-being, physical well-being, and material well-being of personal well-being [1]. How to help the disabled students to use their digital tools to improve the overall quality of life is an important premise for the fairness of the information society.

The biggest difference between digital learning and internet use is that Internet use is far-reaching and covers all aspects of life. Digital learning has learning functions and educational purposes. It provides a teaching delivery system through a network learning environment, through teachers or teaching institutions. The teaching design of

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 398–403, 2019.
https://doi.org/10.1007/978-3-030-35343-8_43

the online enables learners to acquire the resources of learning through information technology, acquire the content to be delivered, and achieve the established educational goals. Cook and Hussey [4] proposed the Human Activity Assistive Technology (HAAT) model, which includes context, personal, activity, and assistive technology, emphasizing individuals' use of complementary technology devices in specific situations. Completion of activities that should be performed, focusing on the impact of activities and the environment on individual performance. A number of domestic and foreign studies have also pointed out that the richness of digital textbook design, curriculum interaction strategies, student management, student characteristics, system and network quality are all factors that may affect the effectiveness of digital learning. The function of digital learning is not only to promote self-development, but also to promote interpersonal interaction, to form a sense of consensus and participation through the online community, to enhance self-worth and presence.

In order to implement the resources for digital learning for the physically and mentally handicapped and to provide a diverse and rich network interface, the Workforce Development Agency in Taiwan launched the "Openstudy eLearning Institute" in 2005 (https://openstudy.wda.gov.tw/mooc/index.php). The information courses offered by the eLearning platform cover computer basic classes, OFFICE classes, web design classes, computer ability certifications, and workplace functions classes. Among them, the "Workplace Function Class" is suitable for students with cognitive dysfunction. It uses multimedia presentation methods to assist learning through text, pictures, animation, video and voice, focusing on the knowledge transfer of employment transfer, interpersonal interaction in the workplace, and introduction of job types. In order to consider the support needed for the interactive process of the physically and mentally handicapped, the system design adopts a class-based teaching interaction method, which is equipped with teaching assistants and tutors to assist the students to obtain support and solutions in the process of learning, and to provide regular online meetings.

Although studies have shown that digital learning systems can help learners with physical and mental disabilities improve their computer knowledge and skills, and increase the range of social activities in life, however, digital learning of the real life of people with disabilities, and the impact on his physical and mental state and social participation remains to be further explored. In view of this, this study used a case study method to study the current situation and needs of the use of digital learning by mentally handicapped persons and their main supporters (family members), and the impact on their personal life. The research results can be used as a leading research on the relationship between digital learning and quality of life for people with physical and mental disabilities.

2 Research Methods

The focus of the research is twofold:

1. The support needed by the physically and mentally handicapped to use the digital learning process.

2. The substantial impact of digital learning on the quality of life of people with physical and mental disabilities.

In this study, a sample of two 18-year-olds with physical and mental disabilities of the same sex, the same age, but different types of disorders and different barriers was selected as a research case. The type of disorder and the degree of disorder in the case are defined by the "Special Education Appraisal Category" identified by the Ministry of the Interior and the "Special Education Appraisal Category" identified by the County Special Education Appraisal Counseling Committee. The basic information of the two cases (represented by Chen and Lee respectively) is shown in Table 1 below.

Table 1. Basic information of the case.

Name	Special education specialized identification category	Obstacle certificate	Obstacle level
Chen	Autism	Category 1 (neural system structure and mental, mental function)	Mild
Lee	Multiple obstacles (intelligent disorder, physical disorder)	Category 1, Category 7 (the movement-related structures and functions of nerves, muscles, and bones)	Moderate

Data collection is carried out in three phases: (1) questionnaire design (2) digital learning course intervention, and (3) effectiveness evaluation and analysis. The description of each stage and its corresponding data collection are described below.

Questionnaire Design: According to the research purpose, the "Digital Learning Questionnaire" is compiled. According to the "Digital Opportunity and Digital Life Needs Survey Report" (National Development Committee, 2015), the content is divided into (1) current status of computer use (2) Computer use ability and (3) Digital learning needs are three-oriented, and the total number of questions is 10 questions. (2) "Taiwan's Concise World Health Organization Quality of Life Questionnaire WHOQOL-BREF". The questionnaire is divided into physical, psychological, social care and environment four Category, the total number of questions is 28 questions.

Reward and Response of Digital Learning Courses: Based on the main learning needs of the two physically and mentally handicapped youths at present, apply the "Workplace Functional Class" course without any hindrance, and conduct 8 teachings, each teaching for 1–1.5 h, the course content Covers (1) introduction of e-network interface; (2) introduction of website exchange area and online synchronization course, (3) career development and exploration; (4) safety of job hunting; (5) interpersonal relationship and gender education; (6) Relieve work stress; (7) Introduction to vocational reconstruction resources and employment; (8) Introduction to the job type of the Grand View Garden. Fill in or dictate the learning feedback form after each course, reflect the personal preferences of the digital learning content, the learning process and the participation of the online learning after class and the personal life benefits. In order to enhance personal development and independent operation, the most commonly used Internet tools (such as mobile phones, ipads, etc.) are used as learning devices in cases.

Interview Record: In order to understand the influence of digital learning on the different dimensions of life quality of people with physical and mental disabilities, the researchers used the questionnaire form project to conduct structured individual interviews with students and parents.

The quantitative data of the documents in this study were analyzed by Excel software, while the qualitative data (observation, interviews and research discussion records, etc.) were analyzed by content analysis. The analysis and research data refer to the coding method proposed by Glaser and Strauss (1967), using open coding, main axis coding and selective coding, and then combining the meanings of coding categories into the core concepts, as the basis for the interpretation of research questions. Improve the intrinsic validity of research through multiple sources of data and triangular cross-checking. The research quality section, with reference to the method proposed by Creswell (2008), is conducted in a trustworthy and competent manner in the research process, and the actual data obtained correspond to the research question as accurately and accurately as possible.

3 Research Findings

According to the analysis of the digital learning questionnaire, the parents of the case have the financial means to provide case computer and network related equipment; they also agree with the convenience and necessity of using the network. Students use the online part of the game for entertainment, contact, and assistance with life matters. In the case of several learning experiences, the two cases have no experience in online learning courses. The main reasons are: (1) not knowing which websites are suitable for learning; (2) not using online learning resources; and (3) needing guidance Guided by teaching.

With regard to the demand for digital learning and the quality of life that is expected to improve, the common needs of the two cases are: (1) the physiological facet focuses on activities of daily living and work; (2) the personal relationship and reality of social relationship Social support; (3) opportunities for new information and skills in environmental facets, opportunities for participation in entertainment and leisure activities; (4) psychological facets, Chen and parents focus on thinking, learning, and memory of this aspect Partly, as well as positive feelings, I hope that after leaving the school system, I can still get the opportunity of continuous learning to enhance my personal learning ability and positive psychological support. Due to his obstacles, Lee and his parents are more focused on the safety and safety of the environmental facets, as well as the availability and quality of social care. Through digital learning, they can increase personal care and access to life and employment services.

The analysis of the teaching feedback form shows that the two cases like and the content in the Openstudy eLearning Platform. They also think that the class is quite helpful for their online learning, communication with people, and information acquisition.

Parents also affirmed the involvement of the teaching of digital learning. They believed that in the past, the one-way browsing of the digital learning platform was played, the children did not necessarily understand or consciously learn, but through the teaching process of digital content, the comparison can absorb the learning content. In addition, the case itself is easier to integrate into different situations such as family, community, school and workplace, and transform this experience into their own ideas, enhance the motivation of learning, and enhance individual independence and social participation.

4 The Impact of Digital Learning

The results of questionnaires and interviews show that the improvement of the quality of life of the two cases is mainly based on the social relationship category and the environmental category, and the partial preference is based on individual orientation. From the two cases and the parents' reactions, we can learn that: (1) Digital learning can effectively and effectively enhance the performance of the "social relationship" category of people with physical and mental disabilities, and expand personal relationships from learning interactions. The learning objects and partners are not limited to family members, the same classmates in the same school or the guidance and supporters of the workplace, expand to the online learning interaction object, and increase the interpersonal communication and social contact with different age groups and different background learning objects by participating in the digital learning course; (2) Breaking through the learning environment The limitation is to increase the opportunities for new information and skills in the "environmental category" through digital learning. The case selects the digital learning medium (such as mobile phone, IPAD) that suits individual needs, the course content that you like to learn, and decides to repeat learning. The number and timing of the time.

It is worth noting that the difference between the individual traits of the case and the independence of learning will also have different degrees of impact on the quality of life of the individual. Due to obstacles, Lee's personal daily life, personal actions and learning activities have long been arranged by parents. As a result, the participation of digital learning activities is still carried out in a "unidirectional" learning style, with a focus on learning content and passive acceptance of digital learning courses. In short, Lee's personal initiative is relatively low. Without continuous learning support, it is easier to give up digital learning. Chen has been involved in various activities since childhood, and has a high degree of acceptance of new things. He likes to interact with different objects, and he needs to use information for paperwork and record work because of his personal work environment. Therefore, digital learning has a higher motivation and willingness to learn, and can achieve "two-way" interactive learning. As far as the overall quality of life is concerned, digital learning can improve the personal development of Chen and enhance his or her personal thinking and learning at the psychological level. In the environmental category, not only can new information and skills be acquired, but also practical applications can be applied. Through the teaching support of digital learning, Chen participates in the online community and related activities, gains practical recognition, respect and acceptance in the field of social relations, for digital learning Not only is the result satisfactory, but also the feeling of positive emotional support and enjoyment.

5 Conclusions

Based on the different physical and mental traits and digital learning needs of the two cases, this study uses the Openstudy eLearning Platform to conduct digital learning courses, and guides students to develop physical, psychological, social and environmental aspects of life quality through the interactive learning process. The results of the study show that it is feasible and effective to use information technology to assist people with disabilities to improve the quality of life of all aspects. However, the personal traits of the disabled, the differences in learning independence, and the level of integration of personal work experience all affect the improvement of their quality of life. In addition, in order to effectively achieve the set goals, the assistance of others (such as the parents of the case) is crucial. Therefore, in addition to providing a digital learning platform for the disabled, the Government needs to further establish a teaching and counseling mechanism for the disabled to assist those who do not have parental assistance or who are unable to assist the parents to participate in the opportunity of digital learning to enhance the overall quality of life.

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Evaluation, Assessment and Test

More Than just Fame: Learning from Internet Celebrities—Uses and Gratifications Perspective

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Abstract. In recent years, the Internet Celebrities (ICs) have emerged as the most influential factor on adolescents. Although ICs are simply other users uploading their user-generated content (UGC), they attract followers through their unique combination of similarity, sociability, and a sense of being different from the audience. While ICs were widely discussed in fields like marketing and youth culture, few researches studied their education value. Our study utilize Uses and Gratifications Theory to extract students' perceptive motivation to learn from ICs' videos. We surveyed 101 high school students about their motivations to use ICs' video to learn enterprise finance. These students considered Entertainment, Convenience, and Information were major gratifications they would get by learning from ICs' videos. We also found past experience with ICs' videos did influence student's perceptive Escapism gratification.

Keywords: Uses and gratifications theory (UGT) · YouTuber · Internet celebrity · Media in education · Secondary education

1 Introduction

Researches have shown student engagement is critical to academic performance while disengagement may lead to dropout. Subjects those are less relative to students' life or require more cognitive resource to understand alienate their learners more. Although student engagement is considered to be a meta-construct with many levels of student's own bioecological influence, teachers still have some control over it [1]. For instance, teachers can increase the number of class interaction or provide more attractive materials. These student-centered approaches can motivate learners more than conventional teacher-centered approaches [2]. One major feature of student-centered approach is students can choose how they learn. If a learning resource can make students pay more attention and be more gratified, it will certainly engage students better.

For instance, with the aid of Web 2.0 technology, a new breed of "celebrities" emerged and became one of the most influential figures to teenagers. "Internet Celebrities" (IC) refer to these people who regularly publish user-generated content

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 407–416, 2019.
https://doi.org/10.1007/978-3-030-35343-8_44

(UGC) on social media platform and gradually capture public's attention. In 2014, Variety magazine reported that 60% of teenagers from 13 to 18 years of age consider an IC as the most influential figure [3]. Today, some ICs have millions of followers and even billions of views of their channels. The influence of ICs has not only surpassed that of celebrities; teenagers consider this nontraditional celebrity to be more trustworthy than a traditional celebrity [4]. According to several surveys, the IC has also become the most desired career for adolescents and children. In China, schools have been established just to train students to become ICs. As Choi and Berger [5] stated, in ancient times, people tend to learn behavior from the most talented hunter because they were excellent at survival. In modern times, people are likely to imitate these celebrities' behavior. Since the change in behavior is a signal of learning, ICs can certainly provide educational value to their viewers. For instance, Choi and Behm-Morawitz [6] found watching ICs' videos motivates emerging adult viewers to engage in video production as well as digital literacy skills. However, the tones of the videos such as humorous or threatening would engage their viewers under different level [7]. Accordingly, how ICs' video engage students may require more studies.

The uses and gratifications perspective is useful to understanding ICs and their viewers as it helps explain media users' motivations for media use [6]. On the contrary with early mass communication pilgrims, the uses and gratifications theory (UGT) assume "the audience is conceived as active" [8]. This means that people are actively seeking and selectively choosing their media, which makes them goal oriented, motivated, and purposive in their media use in order to achieve goals. UGT is highly relevant today as the emergence of digital media has made it easier to transition people from consumers to active audience in which they "archive, annotate, appropriate, and recirculate media content in powerful new ways". As a result, we used UGT to analyze the perceptive uses and gratification to view ICs' video as a learning resource.

In the current research, we studied the perceptive uses and gratification in a vocational high school's enterprise finance class. The course contents include various kinds of spread sheet and ratios that are important to the evaluation of a company. However, these materials are not relative to the high school student's daily life and are usually too abstract for teenagers. Students always felt bored in class and performed badly in exam. Since teenage students enjoy watching ICs' videos, prior researches also demonstrated the taking place of learning watching these videos, we'd like to understand whether students consider ICs' video can help them learn these cold financial knowledge. Additionally, what would be the major factors that trigger them to watch ICs' video and learn?

2 Literature Review

2.1 Internet Celebrities and Their Influence on Audience Learning

The Internet has become the center of many people's lives today and is used for entertainment, to connect with friends, and to search for useful information and recommendations. With the emergence of Web 2.0 applications, anyone is able to produce and share his or her content on the Internet. Sometimes, a large audience is attracted by

UGC, making their producers famous. These now-famous producers of Internet content are known as “Internet celebrities” (ICs) [9]. Unlike traditional celebrities, who mostly become famous from drama or musical performances for the public, most Internet celebrities are popular because of their informative and entertaining video clips. These clips are usually up-to-date and highly relevant to students’ experiences. Although the majority of the clips are filled with jokes or are nonsense, many others provide decent knowledge [10]. As a result, many professors and teachers utilize video clips from websites, such as YouTube, as aids in their teaching because students are found to be more willing to learn and remember more from these clips than through traditional methods [10]. The following are three possible reasons: Internet celebrities have credibility in their field, they are more similar to students than are traditional teachers, and their video clips are usually full of entertainment.

First, students are willing to listen to Internet celebrities because they have established an image of specialty and even professionalism in a certain field [11]. Although teachers have been certified to teach certain subjects, they might not specialize in a particular topic. Whereas teachers have professional training and experience, ICs are proven through time and the market. Moreover, teachers need to prepare classes for the entire semester, which can limit the depth at which certain subjects are taught. In contrast, ICs can focus on a unique issue for days or even months and provide much deeper content. In addition, students tend to trust people who are famous. Previous studies showed that companies, especially those that sell sporting goods or cosmetics, have used celebrities to successfully promote their merchandise. Statistics show that boys and girls have greater confidence in these celebrities and consider what they represent to be trustworthy and useful as well.

In addition, students may understand and relate more to ICs than their teachers because they may find strong similarities between themselves and ICs. This mechanism might work for two reasons. First, students are likely to be influenced by their peers. In their teenage years, people are more influenced by their peers than their parents or teachers. Because students are likely to copy what others are doing, if some of their peers are following ICs, others will soon follow as well [5]. Second, students may believe that ICs are people they can imitate because they might be similar in age, language use, and lifestyle [11]. ICs are similar to everyone else: they were not famous until their published content became popular. Their lifestyle and daily agendas are not much different from that of their audiences. This image will strengthen the self-efficacy of students who think, “I can also do it.” Some studies reported that ICs may even utilize their parasocial influence to glue the audience to their channel [4].

On top of the reputation of ICs and the similarity between them and students, students might be more interested and remember more from their video clips—that they find entertaining—than they do from traditional methods [12]. For example, ICs may use numerous techniques to attract and maintain audiences’ interests. To make the videos interesting, ICs usually include many special effects or dramatic behavior to capture their audiences’ attention [6]. Khan [12] found that relaxing and entertaining videos promote audiences’ engagement. Higher attention and higher interest can actually make students learn and memorize better. Videos that attract audiences will more likely enhance the possibility to imitate [6]. However, the mechanism among various groups of audiences may be different. Some scholars found that people of different sexes and ages may pay more attention to different factors [12]. With the aid of theory, we can examine the impact from a systemic point of view.

As previously shown, ICs have established a unique position that makes it difficult for other roles to compete. Many researchers studied how companies cooperate with ICs to promote their brand or products [13]. They also found that electronic word-of-mouth (eWoM), parasocial relationships, and past success influence audience behavior [9].

Because changes in behavior can be considered the effect of learning [5], some scholars attempted to explore the learning potential of IC clips [6, 11]. Choi and Behm-Morawitz [6] analyzed 102 videos by beauty gurus and found that technology was used in these clips. They also found that audiences are willing to imitate ICs by using similar technologies to produce videos. Johnston [11] developed a case study on two most subscribed sex education channels to extract the reason for the fame of educational ICs. Her conclusion was these top channels allow audiences to feel familiar yet different from them. ICs' gesture and face the camera as if talking directly to the audience, making the audience feel as if they engaged in a chat with the IC. Professional production techniques and slogans or theme songs make the audience aware that ICs are different from themselves. This combination makes ICs special and might be why they became powerful in the teaching media, especially when other media have failed to effectively teach specific topics.

2.2 UGT Motivational Model and Its Evaluation

UGT is a widely-used framework in media research, revealing why and for what people use media [8]. The major objectives of UGT framework include: to explain how people use the media to gratify their needs and to unearth the motives for media use. Grounded in psychological and social contexts, user motives of media use are influenced by the context in which media use occurs. Motives guide media consumer behavior in terms of choice making between different media alternatives. For example, individuals may need to satisfy their information needs through media consumption. One key premises of UGT is that the audience is "active" and seeks to fulfill its needs and receives satisfaction when a need is met [8]. The term "active" that was initially associated with uses and gratification involves selecting content and actively interpreting that content. With the advent of newer interactive media where users can participate in the form of commenting, the meaning of the UGT's active audience assumption has also evolved. Online, active audiences are "selective, self-directed, producers as well as consumers" of information. However, in the content of YouTube and other social media, most users choose to view a video and read text or comments, thereby engaging in media consumption.

UGT is a broad framework to help understand user motivations, and it has been refined over the years by various media scholars. More recently, studies attempted to unearth the motivations for social media use; such as, Instagram, Facebook, digital photo sharing on Facebook, Pinterest and Twitter use [12].

In terms of YouTube use, there were few studies that have attempted to probe motives for site use. Choi and Behm-Morawitz [6] employed the UGT framework to understand YouTube motivations in terms of viewing and making. They discovered that videos were made for self-expression. Khan [12] also found YouTube viewer are most gratified by relaxing entertainment and seeking information.

Although various studies employed the UGT to highlight the motivations behind participating in YouTube, they fell short of discussing how specific type of YouTuber influence viewers' gratification. On the contrary, some researches shows social interaction and group belonging are keep factors that motivates users' usage of other social media, such as Twitch [14], especially if the users were drawn by the livestreamers. Accordingly, our study fills the gap in research in light of new realities whereby participation is manifested by various uploaders.

This claim leads us to our first set of research questions:

1. What might motivate high school students to learn enterprise finance by watching ICs' video?
2. Do high school students consider some gratification higher than others while learning enterprise finance by watching ICs' video?

2.3 Influence from Past IC Experience

Earlier researches [15] indicated the frequency using social media on a personal base would associate with professional use. Social media such as YouTube shows higher association between teacher's professional and teaching use. Furthermore, prior experience using e-Learning/blended learning also influence teacher's use of social media in class. According to the literature review, prior experience did influence the attitude and behavior of teacher's use of Social Media. However, how do different type of media affect different motivation is still unknown. Besides, does the experience effect also apply to students? We would like to address the following questions and propose the following research questions:

3. Do students who have followed one or more ICs have different gratification compared to students who have not when learning enterprise finance by watching IC's video?

3 Method

3.1 Participants and Procedures

101 first-year high school students were recruited from three classes of an Information Processing Department in a general commerce course at a vocational high school in Taiwan. Out of these 101 students, 49 are male and 52 are female. More than 70% of these students had one or more specific ICs following.

3.2 Research Instrument

This research utilized questionnaires about perceptive uses and gratifications viewing IC video to help enterprise finance learning. The questionnaire was distributed prior to the teaching of the subject.

To evaluate students' motivation according to UGT we adapted questionnaire from Bae [16]. This questionnaire measure Socialization, Convenience, Social Support, Information, Entertainment, and Escapism. Each item was measured with a 7-point scale ranging from (1) definitely false to (7) definitely true. For example, Escapism and Entertainment was measured by asking participants to indicate the extent to which they agreed with each of the statements, such as "I was able to get away from what I was doing by learning from IC's videos" (Escapism gratification) and "It was enjoyable learning from IC's videos" (Entertainment gratification).

The measurement of Socialization consisted of three items, Convenience consisted of four items, Social Support consisted of four items, Information consisted of four items, Entertainment consisted of three items, and Escapism comprised seven items. The Cronbach's alphas of each subscale (Socialization, Convenience, Social Support, Information, Entertainment, and Escapism) are listed in Table 1. All of the Cronbach's alphas are in a "very good" range [17].

Table 1. Reliability of UGT questionnaire.

UGT Aspect	Cronbach's α
Socialization	.883
Convenience	.907
Social support	.776
Information	.859
Entertainment	.880
Escapism	.847

3.3 Data Analysis

We used quantitative data to analyze the possible influencers of gratifications. With regard to the degree of gratification, we used descriptive analysis to evaluate the perceptive gratification level of each aspect. To test the difference of gratification level from different aspects, we used paired *t*-test. This method allowed us to compare between specific gratification aspects. We also used *t*-test to compare students who had followed specific IC and those who had not, in order to extract the possible perception differences they had.

4 Results

4.1 Descriptive Analysis

To evaluate the perceptive gratification using IC's video to learn enterprise finance, we first calculated the mean and standard deviation of each UGT aspects. The result is shown in Table 2. Out of the scale of seven, all gratification aspect had means above the neutral level, four. In response to the research question 1, students considered they might feel gratified from all six aspects.

Table 2. Average and Standard Error of each UGT Aspect.

UGT Aspect	Average	S.D.
Socialization	4.898	1.419
Convenience	5.242	1.461
Social Support	4.441	1.256
Information	5.167	1.233
Entertainment	6.242	.919
Escapism	4.467	1.137

4.2 Paired *t*-test Between Each Gratification Aspects

Moreover, Table 1 also shows that Entertainment, Convenience, and Information are the top three gratification aspects, ranking from the highest. Social Support, Escapism and Socialization are the bottom three gratification aspects, ranking from the lowest. We used paired *t*-test to analyze whether significant difference appeared between different gratification aspects. The result (Table 3) shows Entertainment is significantly higher than all other aspects. Convenience, Information, and Socialization are in the second group since there is no significant difference among them. Escapism and Social Support followed as third (and last) group. This concludes our research question 2.

Table 3. Paired *t*-test between each UGT Aspect.

UGT Aspect difference	Average	S.D.	t	p
Socialization - Convenience	−.344	1.512	−2.250*	.027
Socialization - Social Support	.486	1.227	3.924***	<.001
Socialization - Information	−.269	1.384	−1.921	.058
Socialization - Entertainment	−1.343	1.400	−9.501***	<.001
Socialization - Escapism	.401	1.326	2.992**	.004
Convenience - Social Support	.830	1.491	5.511***	<.001
Convenience - Information	.075	1.111	.670	.504
Convenience - Entertainment	−1.000	1.388	−7.132***	<.001
Convenience - Escapism	.744	1.483	4.968***	<.001
Social Support - Information	−.755	1.249	−5.983***	<.001
Social Support - Entertainment	−1.830	1.364	−13.282***	<.001
Social Support - Escapism	−.086	1.177	−.719	.474
Information - Entertainment	−1.075	1.310	−8.125***	<.001
Information - Escapism	.670	1.365	4.855***	<.001
Entertainment - Escapism	1.744	1.197	14.425***	<.001

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

4.3 *t*-test Between Students Who Had Followed One or More ICs and Who Had not

Lastly, we used *t*-test to analyze the gratification level difference between students who had followed and who had not followed one or more ICs. The result shew only Escapism was significantly different (t = .315**, p = .002), while all the other five aspects did not differ significantly. To be more specific, students who had one or more ICs following reported Escapism gratification at 4.681 (*S.D.* = 1.105) and students who had not follow any ICs reported Escapism gratification at 3.863 (*S.D.* = 1.004). In response to research question 3, there are partial difference in gratification between students with different experience.

In summary, students were most gratified by the Entertainment elements of IC videos. It is followed by Convenience, Information, and Socialization elements. Students considered the gratification would be least for Escapism and Social Support. However, students who were following one or more ICs reported higher Escapism gratification than students who were not following any ICs.

5 Discussion and Conclusion

In our research, we used UGT framework to survey the high school students' perceptive gratification by viewing IC's video to learn enterprise finance, such as financial ratio and spread sheet. These students considered Entertainment would be the most gratifying aspect watching IC videos to learn enterprise finance. The Convenient and Informative benefits also interest high school students. Since all six UGT aspects had mean above 4.0, which is the neutral level of gratification, watching IC video to learn enterprise finance did provide multiple perceptive gratifications to high school students.

Furthermore, although Escapism is the least gratifying aspect among the six aspects we surveyed, students' experience with IC would influence this specific perceptive gratification. From our research, students who were following at least one IC reported significantly higher Escapism gratification than those who were not.

In consistent with previous researches, watching YouTube video provides entertainment and information gratification [12]. Since high school students find enterprise finance too abstract and too distant, it would be ideal if teachers can embed some of these entertaining and informative video clips to boost students' interests and knowledge at the same time.

Convenience gratification was also a high candidate on student's list. This was less covered in previous researches and was probably overlooked because it seemed so obvious. However, convenience gratification provide extra attraction to teacher since the usage of IC video in class will not be a huge barrier to students. Teachers could utilize the video clips multifaceted approach, such as a pre-requisite assignment or as a group project.

On the contrary with earlier researches [14], the gratification from social support and socialism are on the lower half of the list. This might be the students were "passive" in our research rather than "active", which means they were constrained within specific field rather than freely select their preferences.

Interestingly, students who had deeper experience with IC video considered escapism gratification higher than students who did not. This might come from the different understanding and expectation. Students who were following ICs may see more escapism elements or they transferred their personal experience in this research.

Our suggestions are as follows: To attract students' attention, using videos from ICs seems to be a feasible method. If teachers can find suitable IC videos to play in class, students' concentration levels would likely increase. Moreover, teachers can use IC videos as supplemental materials to enable students to learn extra information or be influenced by ICs. This approach could be beneficial to students' learning. In addition, teachers can spend time watching and even following some ICs to follow trends in their students' preferences. Furthermore, teachers may attempt to mimic some tricks and phrases from ICs to enable them to communicate with students in an IC manner; such tricks might help capture students' attention. Last but not least, similar to what a company should do in today's market [13], teachers could attempt to upload their teaching to social media platforms and establish themselves as ICs. They might trigger students' affection and received more input to strengthen their teachings.

6 Limitations and Future Direction

Our research had the following limitations. First, our research was limited to specific high student group and the result may not apply to other population. Second, the survey of student's IC experience was mere a binary selection. Although it allow us to analyze the influence of student's IC experience, a finer scale may reveal more detail about the effect from individual difference to help us determine the feasibility to use IC video as a learning resource. Lastly, due to the time limit, we only survey prior to the video watching. A post survey could reveal the gratification students have after learning from the IC video. Further study can also utilize the difference between the posttest and pretest to evaluate the satisfaction and continuation intention of students.

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Dimensions of a Learning Organisation in the IT Sector and Secondary Schools in the Czech Republic

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Abstract. Organisations with a learning organisation concept are finding a better position in response to external stimuli, greater flexibility (and therefore the ability to keep up with development) or to improve corporate image through this concept. Employee satisfaction can also be improved by promoting learning. So far, only a few studies have been performed on Czech Republic territory using the Dimension of Learning Organisation Questionnaire. The aim of this study is to compare results in the 2018 and 2019 surveys conducted in the IT sector and secondary schools in the Czech Republic. The results show that there is a statistically significant difference in the significance level $p = 0.05$ in 2018 between the age categories 11–20 years and 21–30 years ($p = 0.04$) in relation to the evaluation of the individual dimensions of the learning organisation. Simultaneously, there is a statistically significant difference between the average dimension rating for organisations with less than 250 employees in 2018 and 2019 ($p = 0.02$). Overall, after comparing the surveys, it is argued that the implementation rate of a learning organisation in the IT sector and in the secondary school sector is roughly the same.

Keywords: IT sector · Secondary schools · DLOQ

1 Introduction

1.1 Learning Organisation

Several authors have devoted themselves to the definition of a learning Organisation in recent years [1, 2]. It was probably Senge's definition that was the most well-known, which defines the learning Organisation as: *"... an organisation whereby people continually improve their skills and achieve the results that they really desire, where they find support, new and dynamic thinking models, where collective thinking and inspiration are welcome and where people are always learning how to learn together."* [3]. In learning organisations, we can record common elements such as leadership and management; culture; systems for communication, information and knowledge; learning levels. There is less emphasis on systems for facilitating and implementing change as well as organisational structure [4]. According to Ticha, eleven characteristics play important role for companies wishing to take learning as part of an

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 417–426, 2019.
https://doi.org/10.1007/978-3-030-35343-8_45

organisational strategy: learning as part of strategy formulation, participative approach, informatics, formative accounting, internal exchange, flexible remuneration system, supporting structures, collection of external information, inter-organisational learning, a learning-friendly atmosphere and a personal development opportunity for everyone [5]. Factors such as learning communities, teamwork, innovation, organisational culture, information sharing, leadership facilitation, knowledge creation, and others are all involved in the good functioning of the learning organisation concept [6].

Organisations that incorporate the learning organisation concept gain a better position in response to external stimuli, have more flexibility (and therefore the ability to keep pace with development), or an improvement in corporate image and knowledge to link resources to customers' needs [4, 7, 8].

The learning organisation positively influences knowledge performance, which further positively affects financial performance. Therefore, knowledge performance provides a link between learning organisation and financial performance [9]. By supporting learning, employee satisfaction with work can be improved, but it is important to realise that with the development of a learning organisation, there is also a growing demand for employees (e.g., increasing the pace of change in the organisation) [7, 10, 11].

Since only a few studies have been conducted in the Czech Republic that deal with learning organisations, the aim of this paper is to compare two studies conducted in two different sectors in terms of learning organisation dimensions. The sectors were selected on the basis of a research of already performed studies, where DLOQ is mostly focused on the education and banking sectors [12]. The IT sector was chosen because of its close connection with banking.

1.2 Measuring the Learning Organisation

Many tools have been developed over the years, depending on the number of learning organisation definitions, to measure and diagnose learning organisations. Marsick and Watkins' Dimensions of Learning Organisation Questionnaire (DLOQ) is used in many studies to evaluate the learning organisation [13].

According to these authors, the culture of the learning organisation is characterised by 7 dimensions: Create Continuous Learning Opportunities, Promote Inquiry and Dialogue, Encourage Collaboration and Team Learning, Create Systems to Capture and Share Learning, Empower People toward a Collective Vision, Connect the Organization to its Environment and Provide Strategic Leadership for Learning. All dimensions are interconnected and correlation between the dimensions, knowledge and financial performance can be recorded [14–16]. According to the studies conducted, only dimensions 2 and 6 (Promote Inquiry and Dialogue and Connect the Organization to its Environment) have a positive impact on organisational performance [17].

The seven dimensions according to Marsick and Watkins have become the foundation of the Dimensions of Learning Organisation Questionnaire, which allows you to measure important changes in climate, culture, systems, and organisational structures affecting learning of individuals [15]. In the basic version, the questionnaire contains 42 grouped questions based on an individual, team/group or organisational level. The questionnaire can be shortened to 21 questions according to the authors' recommendations, so that the validity of the obtained data is maintained. The responses are recorded on a six-point scale (1 = totally disagree; 6 = completely agree). The original version of the questionnaire is written in English, but the questionnaire can be translated into other languages. To maintain the questionnaire's validity, a reverse translation, expert review and Cronbach's alpha coefficient should be performed to ensure that reliability of the dimensions is not significantly lower than the actual work validation reliability [14].

1.3 Small and Medium Enterprises in the Czech Republic

Small and medium-sized enterprises are defined by the number of employees up to 250 persons. In a closer view, they can be divided into small businesses (1–9 employees), small businesses (10–49 employees) and medium-sized enterprises (50–249 employees) [18, 19]. Small and medium-sized enterprises in the Czech Republic represent a significant employer (in 2017 the share of employees of small and medium-sized enterprises in the total number of employees in the business sphere was 58.0%), thanks to their large share in the total number of active business entities (99.8% in 2017) competitiveness, growth and innovation [20].

1.4 Secondary Schools in the Czech Republic

According to data from the Czech Statistical Office for the school year 2017/2018, there were 1,297 secondary schools with a daily form of study in the Czech Republic, employing a total of 38,115 teachers [21]. Schools as a learning organisation create a comprehensive teaching and learning environment, support initiatives or provide opportunities for continuing professional development [22]. As can be seen from the 2012 survey, learning organisation dimensions have a positive and significant relationship to learning and research performance satisfaction [23]. Although the positive impact of introducing a learning organisation in schools is known, there are still schools that do not follow the learning organisation principles.

2 Methodology

In 2018 and 2019, two cross-sectional questionnaires were conducted in the IT sector (2018, small and middle size enterprises) and the education sector (2019, secondary schools) in the Czech Republic. For the questionnaire survey, a shortened 21 questionnaire version of DLOQ was used in the Czech language, which included 7 learning organisation dimensions. To maintain the questionnaire's validity, the questionnaire was translated by two independent translators from English to Czech and then back to English. At the same time, preserving the questionnaire's meaning was assessed. The Cronbach reliability coefficient was calculated for each dimension using IBM SPSS Statistics version 24. The Cronbach alpha values are shown in Table 1.

Although dimension 1 and 4 did not reach 0.7 value, their values are really close to 0.7 and can be considered satisfactory.

Table 1. Cronbach alpha for individual dimensions in 2018 and 2019 (own processing).

Dimension	Cronbach α	
	2018	2019
D1: Create Continuous Learning Opportunities	0.721	0.620
D2: Promote Inquiry and Dialogue	0.860	0.831
D3: Encourage Collaboration and Team Learning	0.761	0.768
D4: Create Systems to Capture and Share Learning	0.683	0.652
D5: Empower People toward a Collective Vision	0.796	0.742
D6: Connect the Organization to its Environment	0.765	0.817
D7: Provide Strategic Leadership for Learning	0.791	0.854
Total	0.933	0.941

The questionnaire was distributed to respondents via e-mail addresses available from the Albertina database [24] in 2018 and from secondary school databases in the Czech Republic at www.stredniskoly.cz [25].

Based on the research conducted, the basic research question was determined whether there is a statistically significant difference between the education and IT sector according to organisation size.

In total, 2,884 respondents from small and medium-sized companies from the Czech Republic were approached in 2018, and in 2019 1304 secondary school representatives were approached. The obtained data was analysed using Microsoft Excel 2016 and IBM SPSS Statistics Version 24 using descriptive statistics, parametric and non-parametric assays at confidence levels $\alpha = 0.01$ and $\alpha = 0.05$.

3 Results

In 2018, a total of 201 respondents participated in the study from the 2,884 respondents approached (6.97% return on questionnaires). The respondents consisted of 137 men and 64 women. A total of 72 staff members (35.8%) and 129 executive members (64.2%) were included in the study.

In 2019, a total of 121 respondents participated in the study from the 1,304 respondents approached (9.28% return). Respondents consisted of 45 men and 76 women. A total of 34 staff members (28.1%) and 87 executive members (71.9%) were included in the study. Respondents aged 31–40 (37.8%), respondents aged 41–50 (28.4%) and respondents aged 51–60 (15.9%) were the largest in 2018. In 2019, respondents in the age range of 51–60 years (47.1%) were the most represented, followed by 41–50 years (24.0%) and 31–40 years (14.0%).

While in 2018 no respondent from an organisation employing more than 250 employees was included in the study, in 2019 1 respondent represented this category. In 2019 no respondents from an organisation employing less than 10 employees participated in the survey. Organisations employing less than 50 employees were the largest in both years (91 organisations in 2018, 73 organisations in 2019) (Fig. 1).

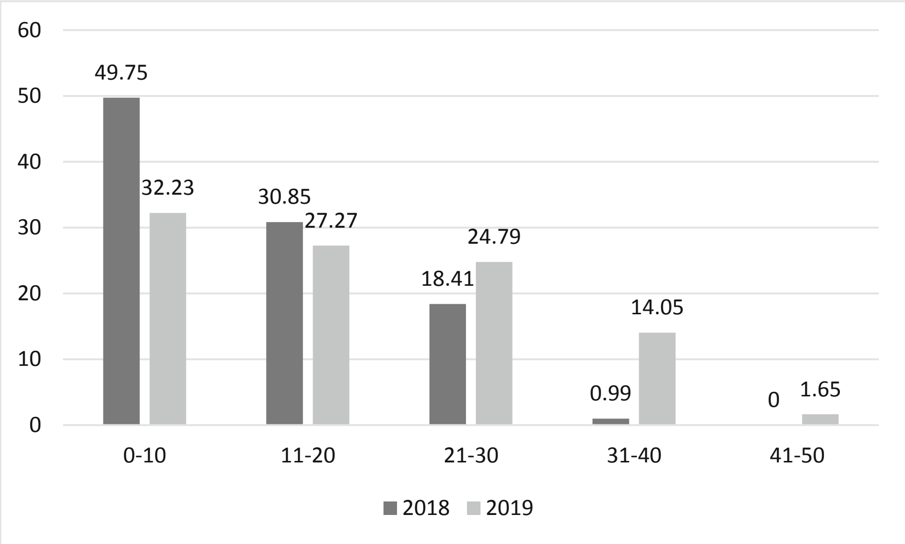

Fig. 1. Percentage of respondents by years of experience (own processing).

If we compare results from individual years, in 2018 and 2019, the employee representatives in the organisation were dominated by 0–20 years (Table 2).

Table 2. Average dimensional evaluation by employment time in the organisation (own processing).

Years of exp.	D1	D2	D3	D4	D5	D6	D7
	18/19	18/19	18/19	18/19	18/19	18/19	18/19
0–10	4.31/4.43	4.32/3.95	4.13/4.11	3.54/4.07	4.18/4.69	3.84/4.43	4.22/4.58
11–20	4.43/4.41	4.24/4.20	4.09/4.37	3.46/4.18	4.30/4.66	3.89/4.32	4.19/4.44
21–30	4.86/4.37	4.79/4.11	4.62/4.28	3.67/3.78	4.73/4.72	4.34/4.33	4.83/4.52
31–40	4.83/4.61	4.67/4.41	2.50/4.45	2.33/4.06	5.00/4.61	3.67/4.71	4.33/4.92
41–50	–/4.50	–/4.50	–/3.83	–/3.50	–/5.00	–/4.67	–/5.00

When comparing the evaluation of individual dimensions in relation to the time of employment in the organisation, a statistically significant difference in the significance level p = 0.05 in 2018 between the age categories 11–20 and 21–30 (p = 0.04) can be observed. If we compare the individual age responses between years, the t-test results for employees working in the organisation for 11–20 years (p = 0.058) are approaching statistical significance at 0.05 (Table 3).

Table 3. Average evaluation of dimensions by organisation employee amount (own organisation).

Org. size	D1	D2	D3	D4	D5	D6	D7
	18/19	18/19	18/19	18/19	18/19	18/19	18/19
<10	4.46/–	4.56/–	4.31/–	3.42/–	4.57/–	4.06/–	4.44/–
<50	4.55/4.44	4.39/4.20	4.28/4.34	3.74/4.02	4.32/4.69	3.96/4.45	4.40/4.59
<250	4.24/4.47	4.11/4.02	3.84/4.17	3.25/4.00	4.00/4.70	3.76/4.36	4.01/4.59
>250	–/4.00	–/4.33	–/4.00	–/4.67	–/4.00	–/4.33	–/3.67

When comparing the assessment of the individual dimensions in relation to the organisation's size, it is clear in 2019 that there is no statistically significant difference between the rating of the different sized organisations. This fact confirms the implementation of the t-test at a significance level of 0.05, where p takes values greater than 0.10. In contrast, in 2018, there is a statistically significant difference between the rating of employees in organisations with less than 50 employees and less than 250 employees (p = .05).

If we compare t-test results for both years for organisations with fewer than 50 employees and fewer than 250 employees, there is a statistically significant difference between the average dimension rating for organisations with less than 250 employees in 2018 and 2019 (p = 0.02). Based on this result, the research question (there is a statistically significant difference between the education and IT sector according to organisation size) can be confirmed.

A cross-correlation between dimensions was demonstrated when comparing each dimension within a survey. A moderate to strong correlation was noted (r = 0.453–0.795).

4 Discussion

This survey compared two studies conducted in the Czech Republic in 2018 and 2019 in two different sectors. In these studies, the DLOQ questionnaire by Marsick and Watkins was used to measure the learning organisation in its shortened 21-question version. To maintain the questionnaire's validity, the rules for translating were adhered to and Cronbach alpha was calculated in both studies. Although the overall Cronbach alpha values were very satisfactory for each study (2018: 0.933; 2019: 0.941), especially in 2019, the two dimensions (Dimension 1 and Dimension 4) did not reach Cronbach alpha 0.7 by several tenths (Dimension 1: 0.620, Dimension 4: 0.652) [26]. Although the optimum value was not achieved for these two dimensions, the reliability values obtained were satisfactory, mainly because the lower value was due to the variability of the individual respondents (secondary schools of different levels - secondary vocational schools, grammar schools, secondary vocational schools, etc.).

The studies carried out in both years can be compared with each other in view of the return on questionnaires and the number of respondents. Given the sectors in which the studies were conducted, the respondents gender ratio is reversed in both studies, consistent with the available gender-specific statistics in the sectors. According to the available data from 2018 in the IT sector, approximately 3 women per 10 men, according to available data, the ratio between men and women in approximately the same values is reversed for the education sector [27].

The age of respondents also varied from year to year depending on the sector where the study was conducted. While the IT sector employs the most employees aged 35–39 in the Czech Republic [28], in education, the average age of employees is 47.2 years [29]. The survey results (i.e. the largest share of IT sector workers aged 31–40 years and the largest proportion of employees in education aged 51–60) correlate with the general statistical data available for the Czech Republic.

When comparing the time in employment in both studies, the most represented are employees with 0–10 years of employment (2018: 49.75%; 2019: 32.23%). The high proportion of employees with short employment in the organisation is related to the fluctuation rate, which generally ranges between 14–16% in the Czech Republic [30], in young teachers, turnover in the Czech Republic is up to 30% [31].

The evaluation of the learning organisation's dimensions in relation to the time of employment with the organisation brings a statistically significant result in 2018, when the individual learning organisation dimensions are better evaluated by employees with employment periods of 21–30 years than with employment periods 11–20 years ($p = 0.04$). This result is probably due to the level of experience gained by individual workers who, after many years, can follow the interests of the organisation more closely and in many cases perceive the organisation in which they work as their own. The statistical significance approached the difference between IT workers and teachers working in the organisation for 11–20 years after the t-test. Most dimensions have been assessed by teachers better than IT staff, due to the different nature of the sectors and therefore the different pressures on individual employees in terms of continuing education and development of the learning organisation (greater demands on self-education among teachers).

In relation to the organisation's size, a difference between sectors can be observed for organisations employing less than 250 employees ($p = 0.02$). As with the previous assessment, the assessment of individual dimensions by teachers is higher than that of the IT sector. In this case, higher ranking can again be attributed to the different approach to lifelong learning, where teachers have a constant need for self-education regardless of the organisation's size, while in the IT sector it can be difficult to keep all workers reasonably self-educated with increasing organisation.

The individual dimensions in each survey correlate with each other, which is in line with Watkins and O'Neil [14], who claim that the dimensions are interconnected.

Overall, when compared to other studies, it is possible to summarize that the evaluation of individual dimensions in the IT sector is higher than in banking [32, 33] and education sector [34–36]. A higher rating was achieved in the education sector in a study from Estonia [37].

5 Conclusion

According to study results in the Czech Republic, the learning organisation concept is being introduced in two sectors and relatively stable results from both sectors have been identified. Therefore, it can be argued that the introduction level of a learning organisation in both the IT sector and the secondary school sector is around the same, and also, the introduction the learning organisation concept in the future should be particularly dedicated to improving the dimensions of lower ratings in both sectors. Specifically, both sectors are Dimension 4: Create Systems to Capture and Share Learning; in the IT sector an improvement could still be achieved in Dimension 6: Connect the Organization to its Environment. Conversely, evaluating the last dimension in both sectors (Provide Strategic Leadership for Learning) suggests that it is supported and targeted in both learning sectors. Although comparisons of two studies have produced interesting results, it would also be appropriate to conduct this study in other sectors in order to gain a more comprehensive picture of the learning organisation in the Czech Republic.

Acknowledgement. The paper was written with the support of the specific project 2019 grant "Determinants of Cognitive Processes Impacting the Work Performance" granted by the University of Hradec Kralove, Czech Republic and thanks to help of students František Hašek and Jan Petružálek.

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Exploring the Interplay Between Students' Co-regulated Behaviors and Their Collective Decision-Making Abilities on a SSI Context

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Abstract. This study aimed to explore the interplay between 10th grade students' decision-making abilities and their co-regulated behaviors in groups on socio-scientific issues. The mixed method was employed in the current study with convenient sampling to invite 38 students participating. They engaged in an SSI decision-making learning module collaboratively (paired in a group). The results of leg sequential analysis manifested that HIRG (higher informal reasoning groups) focused on identifying the demands of the learning task. They would set a specific goal and used strategies after clarifying the demands of the learning task. They also actively regulated their cognitive performance after some monitoring and evaluating behaviors. Students demonstrated higher informal reasoning and employed a specific decision-making strategy in groups in an SSI context if they could clarify the task demands and set a clear goal associated with actively monitoring and regulating their collaborative learning. Further, students' co-regulation was coded as self-regulation, co-regulation, and social shared regulation. In general, the number of students' self-regulation behaviors was identified quite few, and the number of social shared regulation were higher than that of co-regulation. HIRG attempted to perform more social shared regulation for their decision making on the SSI.

Keywords: Socio-scientific issues · Decision-making · Co-regulated behaviors

1 Introduction

SSIs are complex issues and frequently involve competing relationships and people with conflicts of interest embedded in the problems related to society, science, and technology. SSIs instruction aims to provide students with the opportunity to construct knowledge about ill-structured issues and to practice making decisions about multi-factorial issues [1]. Therefore, making decisions about SSIs requires many advanced skills and strategies that need to be developed through collaborative learning. Such decision-making in a social context is known as collective decision making [2] which means each member of the group reach the same decision individually after a group makes a collective decision. Students demonstrate multiple perspectives, understanding the dilemma, evidence-based reasoning, and making a rational and wise decision during their SSI DM process. In addition, students need to express and defend their

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 427–434, 2019.
https://doi.org/10.1007/978-3-030-35343-8_46

reasoning process to clarify and reflect on their decision through argumentation [3]. Therefore, argumentation is one of essential keys for scientific DM [4]. Besides, Venville and Dawson [5] found that students' argument quality and complexity increased after the explicit instruction of argumentation. Above all, this study attempts to explore the interplay patterns between students' co-regulated behaviors and their collective decision-making abilities in a SSI and argumentation embedded context.

2 Method

The mixed method supplemented with a one-group pretest-posttest design was adopted to reach the research purpose. The current study used convenient sampling to invite 38 students participating in this study who were from two schools at New Taipei City and Kaohsiung City.

2.1 Participants

These 38 tenth graders were paired from two senior high school for cooperative learning on the SSI DM task which was embedded a session of argumentation training. The researchers in the current study acted as "observer-as-participant" to observe the interaction within student groups and not to participate any events in classrooms. In addition, the researchers discussed with the school teachers about how to promote students' social interaction and group discussion before and after the classes.

2.2 Data Collection and Data Analysis

The SSI DM learning module is used to promote students' informal reasoning and collective DM abilities through co-regulation. Three types of data were collected including student informal reasoning before and after the intervention, collective DM abilities, and behaviors of students' co-regulation during collaborative learning. Two instruments, the pre-test and the post-test, for detecting student informal reasoning was developed before and after the SSI DM module was conducted. These two informal reasoning tests include one SSI situation with 6 or 7 items separately (6 items in the pre-test and 7 items in the post-test). Each test was administrated for 30 min. We applied the IRT (Item Response Theory) to equalize between the pre-test and the post-test using the data collected from 979 senior high school students.

The SSI DM learning module (6 class periods) applied in this study focused on how to make scientific decision based on evidence and arguments so one argumentation training session (1 class period) is embedded to develop students' ability of evidence-based reasoning following a coastal planning task (5 class periods) coping with climate change, conservation of natural environment, land use, restoring sensitive areas and local economics. Paired student groups collaborate to develop a coastal planning for solving a problem of coastal sand loss. Metacognitive guidance was designed into the SSI DM module to help students think more deliberately about the appropriateness of supportive evidence, of the criteria for selecting the solutions, and of weighting the advantages or disadvantages of each decision, especially when learning to use compensatory and/or non-compensatory strategies for making decisions. Also, metacognitive guidance includes applying visualization tools to provide students with structural support to experience the process of making decisions, and revising their decisions in e-learning contexts. All activities were built in the platform of Google classroom and students' learning behaviors were recorded through the screen-recording software. We referred the differentiation and consolidation theory [6] to design a three-phase SSI DM learning task which includes phases of identifying dilemma, differentiation, and consolidation. In the identifying dilemma phase, students review the reading materials and are guided by the questions in the worksheets to understand the current situation of coastal sand loss at an area, learn engineering techniques for protecting sand loss, and examine 3 possible provided solutions. Students collaborated in a pair to identify the dilemma of these 3 provided solutions regarding conservation of natural environment, land use, restoring sensitive areas, and local economics. In the differentiation phase, students are guided by the worksheets to collaborate and develop criteria for selecting the most appropriate solution among the 3 provided solutions using compensatory and/or non-compensatory strategies and pose their reasons to support their decision. In the consolidation phase, the selected solution from each group are required for peer review of the other group. The suggestions and critique of peer review help to consolidate the decision and reflect on the appropriation of the decision.

A coding scheme for informal reasoning tests and worksheets was shown in the Table 1 which was validated by a science education expert and two doctoral students from science education research field. These two doctoral students completed an acceptable inter-rater reliability for tests and worksheets with a range of .67–.93 of Kappa index. Another coding scheme (Table 2) for students' behaviors of co-regulation was also developed by the researchers to code the screen-recording data after identifying events as an analysis unit. Three types of co-regulative behaviors were recognized including self-regulation learning (SRL), co-regulation learning (CoRL), and socially shared regulation learning (SSRL). In each event, several regulation actions were classified into task understanding (T), goal setting and planning (G), monitoring and evaluating (M), and regulation (R) (Table 3). Following the definitions of the 3 types on the Table 2, the recognized pattern of events is categorized into one of co-regulation types. Two coders selected one particular learning subtask from two paired groups and coded 10% of its transcripts for the interrater reliability using the Kappa index. The interrater reliability was calculated for co-regulation types (.855) and event types (.873).

Table 1. The coding scheme of the SSI DM worksheets and the informal reasoning tests

	A1	A2
Identifying issue stage		
IP11 usage of multiple evidence		1
IP12 reasoning with justifications		1
IP21 indicating the difference between options and the dilemmas		1
Differentiating stage		
DF11 the usage of multiple evidence		2
DF12 making a choose with justifications		2
Consolidation stage		
CS11 the quality of the counterarguments	2	3
CS12 rebuttal	2	3

Table 2. Definitions of co-regulation types (analysis unit: event)

Type	Self-regulation learning (SRL)	Co-regulation learning (CoRL)	Sociallyshared regulation learning (SSRL)
Def.	Focus on what and how to accomplish by oneself and use "I" a lot on student's discourses and answers on worksheets	One key person plays a role of leading the other group member to contribute their effort or to agree the consensus proposed by the key person without negotiations or discussions	Group members negotiate and discuss the learning goals, plans, learning strategies and so on

Table 3. The coding scheme of regulation action

Categories	Description of behavior
Recognizing the task requirement (TU)	Discuss about or read the task requirement on the worksheets
Setting a goal and planning (GP)	Discuss responsibility sharing, division of labors, carrying out the procedure, and planning
Monitoring and evaluating (M)	Evaluate the difficulty of tasks, understanding of task contents, self- and peer accomplishments, and progress of proceeding tasks
Regulating (R)	Discuss how and why to adjust learning behaviors, strategies, or ideas
Carrying out cognitive tasks (C)	Talk about the way of completing the task such as filling in worksheets or reading information

3 Results

The 19 groups' performances in informal reasoning is shown as the Table 4. In the training session, most groups cane not pose high quality counter argument (*Mean* = 0.29) but they performed better in the SSI DM task (*Mean* = 1.63). This echoes Venville's and Dawson's finding [5] about learning better after explicit instruction in argumentation. In addition, students perform well in applying various evidence (*Mean* = 3.61), identifying dilemma (*Mean* = 3.16), and posing defensive reasons (*Mean* = 3.38) but poor performance in posing count arguments (*Mean* = 1.63) and rebuttal (*Mean* = 1.49). The frequency of each type of regulation action and each co-regulation type are shown in the Table 5. The number of all regulation actions was found in this study is 2935. Overall, the most frequent regulation action was "monitoring and evaluating" (frequency = 1160, 39.52% of all episodes), the second frequent regulation action is "carrying out cognitive tasks" (frequency = 938, 31.96%), and the frequency for other three types of regulation actions is less than 10% of all actions. As the Table 5 shown, the number of self-regulation events is only 35 compared with co-regulation events (n = 1175, 40.03%) and socially shared regulation events (n = 1725, 58.77%). The possible reason for this finding is because self-regulation happens internally. Therefore, we will focus on further analysis of co-regulation and socially shared regulation events (n = 2900).

Table 4. Student performance in informal reasoning during SSI DM learning

	Item number	Total score per item	Score of each ability		Score of each item	
			Mean	S.D.	Mean	S.D.
Training session						
Posing counter argument	2	0–3	0.58	0.88	0.29	0.74
Rebuttal	2	0–3	1.47	1.19	0.44	0.59
The SSI DM task						
Applying various evidence	3	0–4	10.84	1.46	3.61	0.49
Identifying dilemma	1	0–4	3.16	1.09	3.16	1.09
Posing defensive reasons	4	0–4	13.53	2.33	3.38	0.58
Posing counter argument	3	0–3	4.89	1.89	1.63	0.63
Rebuttal	3	0–3	4.47	1.98	1.49	0.66

For further analysis of interplay between students' co-regulated behaviors and their collective decision-making abilities in a SSI and argumentation embedded context, these 19 groups were classified into higher (top 27%), middle (the other) and lower (bottom 27%) information reasoning groups based on the score of the pre-test. The frequency analysis among these three groups is shown in the Table 6. The lower information reasoning group (LIRG) (n = 425) performed least regulation actions than the other two groups (the MIRG group: 1356 and the HIRG: 1119). Even though the frequency of the HIRG was less than that of the MIRG, the difference is due to the less frequency in “recognizing the task requirement”. For the analysis of co-regulated behaviors, HIRG tended to perform more co-regulation (73.19%). In detail, the HIRG performed more monitoring and evaluating (40%) and recognizing the task requirement (33%); the MIRG also performed similar patterns of co-regulation; the LIRG attended to perform more recognizing the task requirement (49%), and less monitoring and evaluating (27%).

Table 5. Frequency of regulation actions and co-regulation types

	Sum		Self-regulation		Co-regulation		Socially shared regulation	
	f	%	f	%	f	%	f	%
Recognizing the task requirement (TU)	277	9.44	1	0.03	118	4.02	158	5.38
Setting a goal and planning (GP)	198	6.75	1	0.03	74	2.52	123	4.19
Monitoring and evaluating (M)	1160	39.52	30	1.02	438	14.92	692	23.58
Regulating (R)	362	12.33	3	0.10	154	5.25	205	6.98
Carrying out cognitive tasks (C)	938	31.96	–	–	391	13.32	547	18.64
Sum	2935	100	35	1.19	1175	40.03	1725	58.77

Table 6. Frequency of regulation actions and co-regulation types among different informal reasoning performance groups (higher, middle and lower).

Regulation actions		Sum		Co-regulation		Socially shared regulation	
		f	%	*f*	%	*f*	%
TU	LIRG	47	11.06	20	4.71	27	6.35
	MIRG	112	8.26	63	4.65	49	3.61
	HIRG	117	10.46	35	3.13	82	7.33
GP	LIRG	17	4.00	6	1.41	11	2.59
	MIRG	92	6.78	42	3.10	50	3.69
	HIRG	88	7.86	26	2.32	62	5.54
M	LIRG	116	27.29	46	10.82	70	16.47
	MIRG	561	41.37	265	19.54	296	21.83
	HIRG	453	40.48	127	11.35	326	29.13
R	LIRG	37	8.71	13	3.06	24	5.65
	MIRG	227	16.74	107	7.89	120	8.85
	HIRG	95	8.49	34	3.04	61	5.45

(*continued*)

Table 6. (*continued*)

Regulation actions		Sum		Co-regulation		Socially shared regulation	
		f	%	*f*	%	*f*	%
C	LIRG	208	48.94	106	24.94	102	24.00
	MIRG	364	26.84	207	15.27	157	11.58
	HIRG	366	32.71	78	6.97	288	25.74
Total	LIRG	425		191	44.94	234	55.06
	MIRG	1356		684	50.44	672	49.56
	HIRG	1119		300	26.81	819	73.19

Note: TU: Recognizing the task requirement; GP: Setting a goal and planning; M: Monitoring and evaluating; R: Regulating; C: Carrying out cognitive tasks.

4 Conclusion

Most of co-regulation actions were found as "monitoring and evaluating". Also, the types of co-regulated behaviors were recognized as co-regulation and socially shared regulation mostly across HIRG, MIRG and MIRG. Especially, the HIRG attempted to use socially shared regulation for their SSI DM task. However, MIRG performed the most regulation actions. Besides, the post-test score means of informal reasoning showed that students' informal reasoning abilities were improved in general but they did poor in posing counter arguments and rebuttal. The SSI DM module guided students to review and to criticize the readings from the way of comparing pros and cons between solutions in order to recognize the dilemmas. This leads students to examine various evidences and develop multiple perspectives about SSI; then, they could perform much better in informal reasoning by considering multiple sources of the data. Also, an explicit DM framework was embedded in the SSI DM module to help students generate useful criteria for making a decision; this echoes the researchers' finding [6–8]. The training of argumentation before the SSI DM module promotes students' development of abilities to reflect and evaluate on their evidence-based reasoning and decision-making processes. According to the self-regulation theory, reflection and evaluation play an important role in learning [9] so the peer review activity in this module also guides students become aware of their learning status. All above designs improve students' informal reasoning abilities.

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The Roles, Behaviors and Expectations of the Participants in the Development of Student Graduateness

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Abstract. Graduateness in higher education research forms part of the discourse on the readiness of graduates to take their rightful place as productive citizen in the professional world. The link between graduateness and employability is characterized by a collection of attributes and professional skills that makes a graduate employable. Although the task of developing graduateness is regarded as a critical outcome to enable students to obtain employment it is not directly addressed in the modules that comprise a degree. Academics find it difficult to incorporate the noncognitive attributes of graduateness in teaching partly because of a lack of clear definitions. As a result of this lack in an ODL context, it may be even more difficult to develop students' graduateness than in a residential setup. By analyzing approaches to develop graduateness through a Role Theory lenses it is possible to come to an understanding of the roles, behaviors and expectations evident in the key participants in developing graduateness. These aspects are expressed and captured in a model that serves as the foundation for creating approaches to the development of graduateness in an ODL context.

Keywords: Graduateness · Role theory · Model · Open distance learning · Behavior · Expectations

1 Introduction and Background

Graduateness in higher education research forms part of the discourse on the readiness of graduates to take their rightful place as productive citizen in the professional world. The term, graduateness is linked to employability [1] since it is seen as a collection of attributes and professional skills that makes a graduate employable and therefore of use by an industry in need of professional skills. The graduateness concept, however, encompasses more than just the process to acquire the skills, knowledge and understanding required by the labor market while studying for a university degree. Graduateness also includes the development of certain attitudes and orientations towards the labor market, self-development and responsible citizenship [1, 2]. During 2000 at a national Vice-chancellors' meeting in South Africa, universities were given the task to create a balance between 'education for the marketplace' and 'education for good

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 435–445, 2019.
https://doi.org/10.1007/978-3-030-35343-8_47

citizenship' to foster a civic responsibility in university students [2]. This task created a mandate for universities to place more attention on developing students' graduateness.

The University of South Africa (Unisa) is the only comprehensive dedicated distance education university in South-Africa and applies what is known as an Open Distance Learning (ODL) policy [4]. Distance education is characterized by the physical separation between the learning institution and its students. The 'distance' also includes time, economic, social, educational, epistemological and communication distances between not only the institution and its students, but between students themselves too [5], leading to transactional distance, the "distance of understandings and perceptions, caused in part by the geographic distance, that has to be overcome by teachers, learners and educational organizations if effective, deliberate, planned learning is to occur" [6]. Open learning refers to an approach where the institution allows students to have flexibility and choice in what, when, where, at what pace and how they learn [4, 7].

Open and distance learning "stresses at the same time openness concerning access, organization and methods, flexibility in delivery and communication patterns, and the use of various technologies in support of learning" [8]. Unisa combines the characteristics of distance education and the approach of open learning into ODL, "a multi-dimensional concept aimed at bridging the time, geographical, economic, social, educational and communication distance between student and institution, student and academics, student and courseware and student and peers" [4]. It also focuses on "removing barriers to access learning, flexibility of learning provision, student-centeredness, supporting students and constructing learning programmes with the expectation that students can succeed" [4]. The move towards integrating communities and learning introduces a third critical element in the ODL dynamic namely a learning context that facilitates graduateness. In Fig. 1 this added aspect is termed Work & Society.

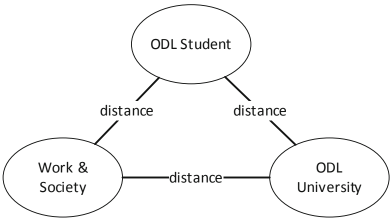

Fig. 1. Key ODL participants.

Although the task of developing graduateness is included as a critical outcome of a degree and is indeed a very important outcome to enable students to obtain employment, in our experience graduateness itself is seldom directly addressed in the modules that comprise a degree. Academics find it difficult to incorporate the noncognitive attributes of graduateness in teaching [9], partly because these are not clearly defined [8]. In an ODL context, it may be even more difficult to develop students' graduateness than in a residential setup.

Some universities have incorporated academic literacies, Work Integrated Learning (WIL) and peer/self-assessment learning and teaching strategies to develop graduateness [9]. Engagement with a community as a component of in-service learning is viewed as a means to combine the two educational goals of developing a deep and wide knowledge as well as social responsibility and ethical behavior [10]. In-service learning can help students develop new perspectives and experiences, critical thinking, communication and planning skills, awareness of diversity, commitment to society and education; and also reinforce positive attitudes towards teamwork, as well as increase self-esteem and knowledge of themselves [3, 10, 11]. A sense of community in a course or module has also been shown to improve student success in an ODL environment [12].

Vygotsky's [13] theoretical framework emphasizes the fundamental role of social interaction in learning. According to [14], when students experience their learning environment as supportive and caring, "they are more likely to develop positive attitudes toward themselves and prosocial attitudes and behaviors toward others". These positive attitudes are cultivated by encouraging students' sense of "community", "connectedness" and "belonging". Creating an environment that encourages social interaction in the sense of belonging to a community inclusive of the University, student and Work & Society is of critical importance. [15] claims that employers are more interested in prospective employees' social-emotional skills than their academic results and argues that more research are needed to develop interventions to foster these skills. Noncognitive skills play an equally important role as cognitive skills in both academic as well as professional success [15, 16].

What is, however, not universally understood nor known is how to establish this sense of community for the student during the learning task as well as the period of in-service learning. More specifically, given the tripartite relationship between University, Student and Work & Society (Fig. 1), what should be clearly defined as the roles and responsibilities associated with each stakeholder in the relationship. Addressing this lack of understanding forms the main aim of this paper and is expressed as the following research question: 'What roles and responsibilities can be assigned to the stakeholders in the aim of developing the various attributes of graduateness in an ODL context?'

2 Theoretical Framework

To address this gap in the understanding of how to create social interaction in an ODL context to develop graduateness, it is necessary to explore the core concepts such as graduateness and learning in a community. This exploration includes a discussion of approaches that integrate teaching with work and society.

2.1 The Meaning of Graduateness

The meaning of graduateness is much debated in the academic literature but has not yet coalesced into a universal definition nor a set of core graduate attributes. While there is overlap in the qualities expected of a graduate, each institution typically formulates their own definition in order to distinguish their graduates from those of other institutions [2].

From a global perspective, two studies provide insight on an understanding of graduateness. The Assessment & Teaching of 21st Century Skills (ATC21S) project based at The University of Melbourne in collaboration with CISCO, Intel and Microsoft, identified ten skills in four categories, namely ways of thinking (creativity and innovation, critical thinking problem-solving, decision-making; learning to learn/metacognition – knowledge about cognitive processes); ways of working (communication, collaboration or teamwork), tools for working (information literacy, information and communication literacy) and ways of living in the world (citizenship – local and global, life and career, personal and social responsibility – including cultural awareness and competence) [33]. According to [17], The World Economic Forum report, New Vision for Education: Fostering Social and Emotional Learning Through Technology, lists 16 21st century skills classified into three categories: foundational literacies (how students apply core skills to everyday tasks: literacy, numeracy, scientific literacy, ICT literacy, cultural and civic literacy); competencies (how students approach complex challenges: critical thinking/problem-solving, creativity, communication, collaboration) and character qualities (how students approach their changing environment: curiosity, initiative, persistence/grit, adaptability, leadership, social and cultural awareness). As can be seen, graduateness requires traditional cognitive skills such as subject-specific or discipline knowledge as well as non-cognitive skills developed through social and emotional learning. The non-cognitive skills or transferable competencies refer to attitudes and behavior or self-development, such as collaboration, communication and problem-solving skills [17], resilience and adaptability, and non-linear thinking [1]. The non-cognitive skills also correspond with the attitudes and orientations towards the labor market, self-development and responsible citizenship [1, 2] graduates are expected to develop during their studies. Emphasis is also placed on 21st century literacies, including visual, cultural, network, computer, written, media, library, linguistic and global literacy [18].

2.2 Learning in a Community

Learning situated within a formal workplace or society in general provide students with opportunities to engage with their learning and to put into practice the skills and attributes they are developing in their studies thereby incorporating these attributes as part of their identity [19]. Engaging in an online learning community by establishing relationships with fellow students and the instructor can also develop some of these skills and attributes such as gaining a deeper understanding of the study material, and learning how to deal with complexity, tolerate ambiguity and work with others from different backgrounds and different viewpoints [20]. [21] found that reducing transactional distance increases student engagement as well as success in student outcomes.

Creating an appropriate learning environment is largely seen as the responsibility of the lecturer, whether it be online or residential. According to [22] "learning environments facilitate learning processes, and these lead to learning outcomes, which, in turn, determine the learning environment. Teachers in turn design learning environments, facilitate learning processes and assess learning outcomes, while students work within learning environments, engage with learning processes and demonstrate learning outcomes, as well as interacting with their teachers.”. These concepts are captured in the Learning Environment, Learning Processes and Learning Outcomes (LEPO) framework, shown below in Fig. 2.

In the context of student-community engagement defining the student as co-generator connotes a more actively engaged collaborative descriptor of the students’ role than that of either consumer or product. This is one way in which graduates can be shaped and changed by their learning, so that they emerge from higher learning with particular attributes that are now part of their identity, more than just equipped with skills they have acquired along the way. Community experience or service during higher learning may therefore provide a context in which attributes can be developed and enhanced [19]. At the same time, it is important to foster a sense of community under ODL students, both to develop their graduateness and to increase their success rate.

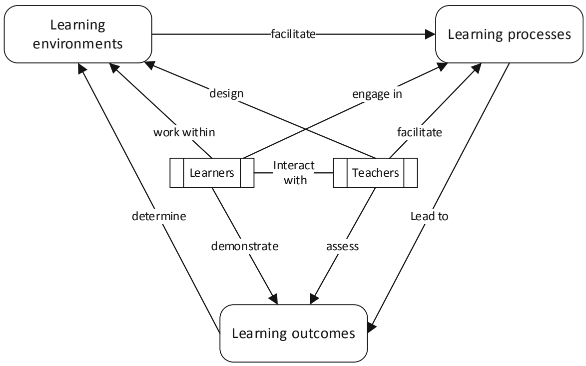

Fig. 2. The LEPO framework [22].

2.3 Approaches that Integrate Teaching with Work and Society

Work Integrated Learning (WIL) is an increasingly popular approach to address the needs identified by graduateness [23]. WIL is defined as “an umbrella term for a range of approaches and strategies that integrate theory with the practice of work within a purposefully designed curriculum” [24]. WIL is explicitly characterized as a partnership between the student, the university and the workplace (industry), as seen against the backdrop of some contextual purpose.

[25] identifies 3 models for implementing WIL namely professional learning, service learning and cooperative learning. Recent developments extend the WIL concept to recognize the integral role of Information and Communication Technologies (ICT) and call it eWIL or electronic WIL [26]. Up to 70% of the undergraduate

students in the School of Computing at the University of Kent spend a year in industry as part of their undergraduate program (reflected in their degree titles), a form of WIL. This experience acts as a transition or turning point in students' life that impact significantly on their graduateness. Students report, amongst others, a change in attitude towards both studies and work, improved time-management and changes in career direction [27], confirming that WIL can have a beneficial effect on students' graduateness. (The University of Kent has a dedicated unit to assist students with placing students for this year in industry.)

[28] created a synergy-based methodology to create a Win-Win situation to achieve the teaching of research skills in a WIL context. Their resultant LRT-WIL framework recognizes four synergy dimensions namely:

- Industry–academia–student synergy
- Work–study interface
- Teaching–research linkage
- Business and education integration: intellectual capital

LRT-WIL, furthermore, provides students with opportunities for:

- learning to be a professional by working and communicating with professionals
- learning to learn by developing skills such as problem solving, and critical thinking based on an integrated research system
- learning to do research by inquiry-based learning to generate new knowledge

[29] developed a theoretical model to create an environment of socially responsive and employable graduates as well as to strengthen partnerships with the industry and the community. In their model WIL is seen as a Learning Component inside an ODL environment, that can be realized by a Mode of Learning such as Community Engagement (CE). Using CE to manage WIL means that the CE Project plays a central part. A CE project can address either formal or informal aspects. The Stakeholders involved in a CE Project includes the university, student, industry and community.

[30] further investigated current practices in the School of Computing at Unisa to develop a best-practices framework for online teaching, research and community engagement (CE) within an ODL context in order to evaluate an online module. She found that most of the activities in the framework *are* conducted in the module, albeit in an arbitrary matter. This evaluation focused on one specific module, and the activities are not necessarily performed in all or even most of the modules offered at Unisa. What it does confirm is that it is possible to incorporate CE in at least some modules. Should lecturers be aware of the use of CE to develop graduateness, more of them may be inclined to incorporate it in their modules.

Whilst it is potentially irresponsible to place inexperienced first year students in the position of serving a community, responsible citizenship is part of the graduateness concept, which involves a social responsibility towards the community. Becoming aware and being involved in some way with a community can develop an awareness of social issues and a citizen's responsibility in this regard.

2.4 Summary and Discussion

The LEPO framework hints at the roles and responsibilities of Teachers (lecturers) and Learners (students) but is silent on the role of work and society. [28] and [30] on the other hand explores the workplace as well as importance of a community awareness but is silent on the potentiality of creating a sense of community amongst students during their time of study. A synergy of these approaches should/could include both a sense of roles and responsibilities as well as an inclusion/expansion of work & society to create a model that will direct the actions of lecturers in fostering graduateness. Such a model/framework will be the first important step in answering the question of how to include a sense of community in the life of a student.

3 A Roles Oriented Model for Graduateness Development

According to Role Theory human beings behave in different yet predictable ways depending on their respective social identities and context. The basic concepts of role theory can be characterized as role, social position, and expectation [31]. More specifically a role can be understood (amongst others) as a behavior associated with a social position [32]. Given the social nature of distance education (ODL) in that at least three socially oriented stakeholders act in relation to each other to achieve graduateness, an analysis of the frameworks discussed above could lead to the identification of specific behaviours towards enabling graduateness.

The analysis will proceed along a 3-phase process. In phase 1 the identified and discussed frameworks will be analysed for information relating to actors and their associated activities. These results will then be interpreted in phase 2 according to the meaning of a role as per Role Theory. In the final phase these results will be synthesised as well as represented in a diagram.

3.1 Actors and Activities

In the LEPO framework 2 main actors are identified namely a learner and a teacher. These key actors interact with the learning components of environment, processes and outcomes. Each interaction is regarded as an activity as described in Table 1.

[28]'s LRT-WIL framework aims at creating synergy between three actors namely, Academics, Industry Partners and Students. The active engagement amongst actors leads to a list of activities as shown in Table 2.

[30]'s best practices framework focusses attention on the best practices exercised or followed by a lecturer along three dimensions. Each dimension contains several activities as tabulated in Table 3.

A synthesis of Tables 1, 2 and 3 leads to a description of Behaviors as well as Expectations held by actors as shown in Table 4.

The relationships between roles, behavior and expectations are shown in Fig. 3.

Table 1. Actor and Activities derived from LEPO framework.

Actor	Activities
Student	Work within learning environment Engage in learning processes Demonstrates learning outcomes
Teacher	Design learning environments Facilitate learning processes Assess learning outcomes

Table 2. Actor and Activities derived from LRT-WIL framework.

Actor	Responsibility/Activity
Academics	Facilitate or broker connection between industry and student, Understand industry needs, Formalizing problems for students, Facilitating students' research and problem solving
Industry partners	Resource and funding providers, Monitor student progress, Exemplars of professional practice
Students	Learning to be a professional by working and communicating with professionals, creating human capital for organizations Learning to learn by developing skills such as problem solving, and critical thinking based on an integrated research system such as research-oriented or research-based system Learning to do research by inquiry-based learning to generate new knowledge

Table 3. Activities derived from [30] best practice framework.

Actor (Lecturer)	Responsibility/Activity
Planning and development of tuition, research and community engagement	Build eCommunity Know and create the course content Elucidate online course anticipations and objectives Design and structure the online course Identify and deploy the appropriate online for interaction
Teaching, research and community engagement activities in action	Engage the online learner Generate a student-centered environment Provide timely, relevant and actionable feedback Create opportunities that encompass practical real-world applications. This will typically be in the form of community engagement projects Incorporate provision for each student's learning process and independence Ensure all course content is freely and easily available to all students Increase lecturer presence for monitoring student learning., enhance lecturer-student relationship and guide student learning
Student assessment and data evaluation of teaching, research and community engagement practices	Evaluate online practices in respect to teaching, research and community engagement

Table 4. Synthesis.

Actor	Behavior	Expectations
Student	Engage in ODL style learning Demonstrate knowledge Engage with professionals Developing professional skills and knowledge	Efficient ODL learning systems and processes Industry relevant knowledge and skills
Lecturer/University	Design and planning of ODL learning Facilitate learning process Assessment of student learning Research and ODL development	Engaged students Industry involvement in relevant course design
Work & Society	Providers of resources or funding	Workplace relevant skills and education

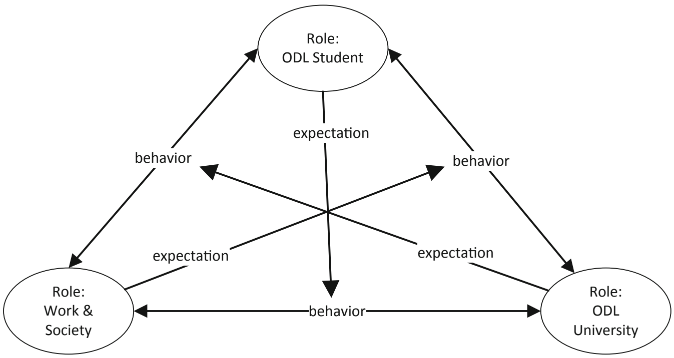

Fig. 3. Role, behavior and expectation model.

4 Conclusions and Future Work

This paper set out to explore an answer to the question of what roles and responsibilities can be assigned to the stakeholders in the aim of developing the various attributes of graduateness in an ODL context. By viewing existing efforts to address graduatness a picture emerges of potentially typical role descriptions. In terms of the participants in ODL these seem to be at least three in number, namely the Student, University and Work & Society. Each of these roles are interacting with each other in terms of a set of behaviors. Finally, each role also has certain expectations about the behavior between roles. This idea is reflected in Fig. 3.

We recognize that this work is, although analytical, a proposal of a conceptual nature. More work is needed to ratify and clarify the three roles, their interactive behavior as well as the expectations on that behavior.

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Innovative Learning in Education

Learning with the Semantic Web: The Case of a Research Methodology Semantic Wiki

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Abstract. The Semantic Web extends the read/write Web 2.0, allowing meaning to be assigned to content and the links between content, leading to the machine processability of this content and potential benefit to teaching and learning. Considering the difficulty that research students have with the concepts that make up the structure of a research methodology, this research explored the value of using a semantic wiki to support the learning and teaching of this structure in computing fields of study. This will add to current online approaches to research methodology learning as well as the use of the Semantic Web in and for learning. Following a design science research approach, a conceptual model of the domain led to an ontology, which formed the basis of the content and structure of the semantic wiki. Research methodology concepts and relationships were realised in the wiki and semantic annotations added to allow improved presentation and exploration of domain knowledge. The wiki was evaluated by both supervisors and research students, finding that there was value in the approach, but that it was not a quick-fix solution.

Keywords: Semantic Web · Semantic wiki · Research methodology · Smart learning environment · Online teaching environment · Higher education

1 Introduction

The emergence of Web 2.0, as well as the possibility of users being both consumers and producers of content, has altered the environment in which information is accessed and knowledge created [1]. University online learning management systems often include tools that can be used to support learning and collaborative knowledge generation, such as discussion forums, blogs, wikis, online debates, group meetings, and reflective journals, and which are also commonly used in massive open online courses (MOOCs) [2]. There is also a growing acknowledgement of the role that other, more open and social, online tools, offered by Web 2.0, can play in promoting learning, albeit informally and outside university control: Facebook, Twitter, and YouTube [3].

Extending Web 2.0, the Semantic Web refers to a "new form of Web content that is meaningful to computers" [4, p. 34], where semantic web technologies provide consistent meaning to online content and support linking such data from various sources

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 449–458, 2019.
https://doi.org/10.1007/978-3-030-35343-8_48

and in different formats. The meaning of data is tied to concepts present in a formal knowledge representation schema, an ontology, that will allow a machine to understand and process the content. Semantic markup is then used to annotate text based on the ontology and to provide meaning and intelligent linking of material.

Recognising that research students often find research methodology complex and confusing, with little consistent use of the constructs employed in the domain [5], the role that the Semantic Web can play in exploiting virtual environments to facilitate learning the structure of a research methodology will be explored in this paper. The research question is, thus, as follows: to what extent can the Semantic Web be used to represent research methodology structure and provide a semantically enriched environment to support learning? This was explored using a semantic wiki to present research methodology structure and was limited to research methodologies common in computing fields of study.

2 Background Literature

2.1 Online Approaches to Research Methodology Learning

There has been considerable growth in alternative approaches to face-to-face modes of delivery at postgraduate level, led by increasing access to web-based technologies [6]. Alternatives to the dyadic supervisor-student relationship include blended learning, where the supervisory relationship is extended to the use online tools to support learning [7]. For example, web pages are used to provide teaching materials and links to further resources (such as language editors and statistics experts) [7]. Furthermore, document submission and supervisors' comments are processed online, thus providing a record of discussions and progress [7]. Asynchronous online discussions have also been used to discuss students' reflective responses to their reading and assignment answers [8].

Research methodology education is not an established field of its own, with knowledge scattered across several disciplinary journals and special interest groups [9, 10]. There is also no formal, proposed pedagogy aimed at teaching research [10], which is acknowledged as a challenging task [5].

2.2 Learning and the Semantic Web

Currently, students searching the Web have to rely largely on keyword searches, often leading to irrelevant material being identified in the large amount of educational material available [11]. The Semantic Web opens up the possibility of more focused searching, leading to better discovery of research material.

Formal semantic annotation has been used in the tagging of learning materials, making them searchable and retrievable (for example, EdNA, Educational Modelling Language (EML), and SCORM) [12, 13]. There are even language-specific resource descriptors, such as the French ScoLOMER, used for learning object metadata [14]. This has led to the move towards collecting existing distributed learning objects, rather than creating them, from multiple sources by intelligent, adaptive e-learning software agents, using known properties of a student and automated reasoning to assemble learning material into a personalized collection, thus using semantic metadata to construct individualised courses [11, 13, 15].

Making resource discovery more accurate, unambiguous, and structured via semantic annotation requires ontologies, which are formal representations of a domain's conceptualisation, providing a controlled, limited, and common vocabulary that defines the concepts and the relationships between these concepts [11, 15]. Ontologies for use in learning include those about students, curricula, educational metadata, and specific subject domains, allowing for the search, reuse, and personalisation of online learning [14, 16, 17]. Ontology use can also be seen in online education environments such as the EduProgression ontology, the official common base of French educational concepts and skills, which has been extended to include pedagogical resources [14]. A semantic wiki has also been used for the maintenance of a vocational ICT curriculum [18].

2.3 Wikis and Semantic Wikis

A wiki is a collection of web pages used to foster the recording of community knowledge and is a widely used tool for knowledge exchange in shared, virtual, and distributed communities, including in higher education [19]. However, a wiki is just a flat set of pages without a strong structure and with a focus on human readers [19], leading to limited search capabilities.

A semantic wiki is the merging of the benefits of a traditional wiki with the Semantic Web, using an ontology to structure and annotate the information included in the wiki. Users provide both content and semantic annotations, which allow machine processability and querying of the content. Every element in the domain, both domain concepts and the typed relationships that link them, is represented by a page in the semantic wiki [20]. Machine processability also allows knowledge in the wiki to be visualised in graphs, leading to better understanding and navigation of the content [18], as well as overcoming the drawbacks associated with traditional wikis.

Although current students are generally believed to be capable users of Web 2.0 affordances, use of online tools for learning may require new ways of thinking, new literacies, and new ways of locating and evaluating information [1]. Yet even though such tools are freely available, they are often used for social purposes by both staff and students and are largely not accepted for academic purposes, leaving questions about how effectively they can be used to support learning [21].

3 Research Methodology

Pragmatism, with its commitment to improving lived experience and effective action [22], formed the philosophical underpinning of this research, which was guided by design science research (DSR) – a problem-solving research design focused on the utility of a designed artefact [23]. The eventual artefact was a semantic wiki that would be used to present the structure of a research methodology in a semantically enriched learning environment.

Noting the need for an ontology on which to base the semantics of the wiki, DSR was merged with ontology engineering approaches, which led to the following four steps/artefacts.

1. Conceptual modelling: the main concepts and relationships representing a research methodology structure were modelled using Unified Modelling Language (UML). This was evaluated using an expert focus group made up of 10 experienced supervisors and is reported elsewhere [24].
2. Description logics (DL): the conceptual model was expressed formally in a knowledge representation language and evaluated manually, ensuring consistency of conversion from the UML model to DL.
3. Ontology: the DL model was expressed in Web Ontology Language (OWL) using Protégé. This was evaluated by populating the ontology with sample data and running queries to test for expected results; the built-in reasoner ensured ontology consistency.
4. Semantic wiki: the ontology knowledge was presented online using Semantic MediaWiki (SMW). This was evaluated using a focus group made up of 10 supervisors, as well as an online questionnaire sent to graduate students doing a research report course. Only this evaluation will be presented here.

SMW is an open-source extension of MediaWiki, which is the engine used to create Wikipedia, and is considered the most popular semantic wiki engine [25]. A thematic analysis approach was used to explore the main themes that emerged from the focus group and open-ended questions in the questionnaire, and simple descriptive statistics gave an overview of the questionnaire responses. Ethical clearance was obtained from the relevant university committees to undertake the research and to include university staff and students in the evaluation process.

4 SWaRM: Semantic Web and Research Methodology

4.1 Semantic Wiki Overview

Conceptual Model Implementation. The semantic wiki, which can be accessed at http://eagle.unisa.ac.za/mediawiki/index.php/Semantic_Web_and_Research_Methodology, was based on a model (Fig. 1) conceptualising research methodology structure. Broadly, there are four main components: a ResearchScheme, PhilosophicalWorldView, ResearchDesign, and ResearchMethod. While these four components each have specific properties, there are also relationships that link the various components. For example, a ResearchScheme isUnderpinnedBy a PhilosophicalWorld View and hasResearchDesign, which may be one or more ResearchDesigns. Both ResearchDesign and ResearchMethod are subclassed into types of designs/methods. The landing page of the wiki presents an overview of this structure, orientating users to the conceptual model used in the wiki; it also describes how the wiki can be used as a consumer and producer and provides links to the four main concepts. Following these links takes the user to pages that describe the concepts and their associated properties.

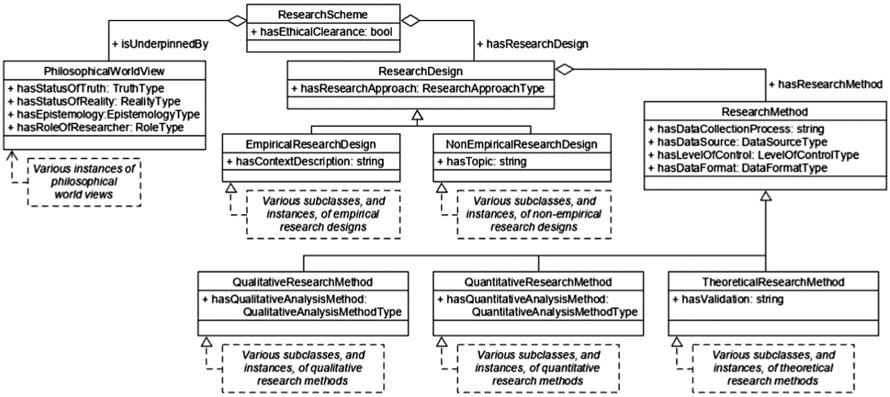
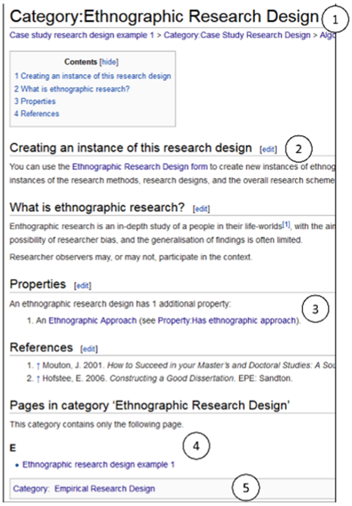


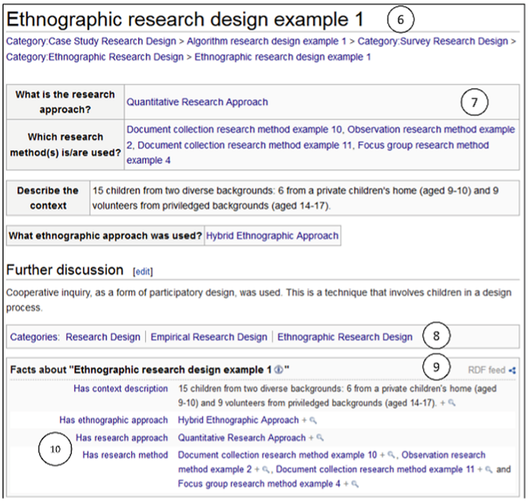
Fig. 1. UML class diagram of the conceptual model.

Semantic Implementation. Each concept in the conceptual model is realized as a Category page (Fig. 2(a) point 1), and both properties associated with concepts (such as Property: Has ethnographic approach, Fig. 2(a) point 3) and the semantic links between concepts (such as hasResearchMethod, Fig. 1) are accomplished using Property pages; these pages provide knowledge about the concept/property, additionally ensuring their consistent use. Semantic annotations are added to concept pages to indicate a parent concept (where there is one in the concept hierarchy, Fig. 2(a) point 5) and the property links, making the concepts and properties machine readable. Forms (Fig. 2(a) point 2) are used to help users create instances of the concepts, so that the semantics are added automatically, and the user does not need to know how to include them. The semantics allow links to pages that fall into the current category to be displayed on the page (Fig. 2(a) point 4); these are generated dynamically as concepts and instances are added to the wiki and so are always up to date. Queries can also be added to pages to present users with dynamic, updated results.

Instances. Normal web pages are used to actualise instances of wiki concepts or categories (Fig. 2(b) point 6). Such pages are created by users for research projects that have been undertaken, showing which components made up the specific research. Once created, these pages display clickable links for the properties of the instance (Fig. 2(b) point 7), which users can follow to find out more about the property. At the bottom of each page are links to the hierarchy of concepts that indicate what sort of page this is (Fig. 2(b) point 8) as well as a fact box (Fig. 2(b) point 9) summarizing all semantics found on the page. Clicking on a property link (Fig. 2(b) point 10) links the user to that Property page, where all other pages where this property has been used can be viewed. The eye symbol in the fact box heading directs users to a page where the incoming links to the instance page can be found, allowing backwards movement through the semantic links. It is, thus, possible to use the semantics present in the wiki to move around the dynamic links that make up the wiki and follow how research methodologies have been structured.



(a) Example Category page



(b) Example instance page.

Fig. 2. Example category page and instance page.

4.2 Responses to the Semantic Wiki

While the supervisor focus group and student survey were used as part of the DSR evaluation process, they may also be seen as an implementation of the wiki in a teaching environment to assess its benefit to supervisors and students in a research report course.

Supervisor Focus Group. The focus group was made up supervisors with a range of levels of supervision experience, and four themes emerged. *What is this wiki?* explored themes around whom the wiki was aimed at and its being a starting point for one approach to the problem of methodology structure. It emerged that a more visual, step-by-step approach might be needed. *Where is its utility?* focused on its potential benefits, and the value of the examples was noted. *How can it be used?* concentrated on how contributing to the wiki would be of benefit, providing students with a variety of approaches that could be used in active learning and fun approaches; however, it would take time to master the approach taken. *Why not use it?* highlighted the uncertainty about the utility of the wiki, with concerns raised about it being confusing and students getting lost in the material. The overall narrative that emerged regarding the value of the semantic wiki was that it would take effort to come to grips with and that it was not a quick-fix solution to research methodology structure.

Student Questionnaire. A web-based questionnaire, hosted in Google Forms, was sent to 316 graduate students; 59 responses were received (a 19% response rate). While 86% of the students had used a wiki 10 or more times, 78% had never contributed to one. Students found that the wiki was easy to navigate (90%), provided valuable information (97%), and helped them understand research methodology structure (85%). Only 19% contributed to the wiki, with lack of enough knowledge being the main concern (38%). Overall, 43% enjoyed using the wiki, 72% found it useful, and 50% indicated that it made them think and that they would use it again. Only 36% would recommend it.

Seven themes were identified in student textual responses. Many found it *useful* and informative, comprehensive, and easy to understand. However, some felt that *more was required* and wanted more of an *overview* and high-level introduction to the content, looking for mind maps, videos, and a step-by-step process to follow. Furthermore, there were requests for *more resources*, such as references to articles and links to relevant software. While the instances in the wiki provided examples, there was a call for *more examples*. There appeared to be a *lack of confidence*, and students were reticent to add content. Finally, students wanted the *content checked*, as they felt that some material was missing or needed editing.

5 Discussion

The aim of this research was to determine the extent to which the Semantic Web, expressed as a semantic wiki, could be used to represent research methodology structure and support its learning. SMW uses semantics to help make browsing and searching more efficient and intelligent through ensuring consistency of structure and content, as well as content reuse [25]. Its dynamic nature means that it will also support the evolution of domain knowledge over time as changes in the domain and the addition of individuals occur. The research methodology semantic wiki demonstrated that it was possible to present domain knowledge in a semantically enabled online environment. Additionally, that pages could be annotated with parent concepts allowed reasoning to be used when dynamically displaying content belonging to a particular concept or property. Likewise, semantic queries on pages enabled related information about the page to be dynamically displayed. These semantic affordances allowed links to be used to navigate the concepts and relationships present in the wiki. Also, the use of semantic forms reduced the complexity of adding semantic annotations to new content.

While there is no single learning theory that can be used to understand online learning [26], any learning environment must be informed by a pedagogy. In this. case, Siemens's connectivist theory of learning [27] may be used to support a semantic wiki approach. Connectivism considers knowledge to have a distributed, networked structure with nodes linked by interactive relationships [28]. Learning is, thus, a process of network formation and navigation. This model of learning is capable of expressing how research students gain knowledge about research methodology structure using semantic links to build interconnections between research methodology constructs. Furthermore, as the semantic wiki networked knowledge is machine processable, dynamic knowledge representations and reasoning over such representations are also possible.

A semantic wiki also supports sociocultural views of learning and their associated communities of practice [29], and such wikis are well suited to the presentation and development of the body of knowledge that such a community maintains. The wiki approach allows research students to be brought into communities of professional research and scholarship practice, where an apprenticeship into the academic discipline may occur [5].

Although many of the responses to the wiki pointed to a preferred approach that provided a recipe-like, step-by-step process, it needs to be understood that the wiki is not a quick point-and-click solution to understanding and building a research methodology. Furthermore, as the basic structure of research schemes had already been set up based on the conceptual model, the participation that followed was expected to be the addition of instances of research schemes, providing examples of how researchers had structured their work. Thus, although the wiki could support learning and teaching in a community of practice, it was not used like this in any substantial way. Its use was largely limited to exploring the structure and examples that were already present, and little new material was added by supervisors or students. This could be because supervisors had their own conceptualisations of the domain, which did not fit with that presented in the wiki; students might not have thought that they had the knowledge to do so.

However, the feedback from students suggested that the approach was comprehensive and valuable and helped in understanding methodology structure. Thus, although the provision of a standard terminology, which helped students navigate the complexities of research methodology structure, might not have been seen by some as that useful yet, it might have helped students negotiate the domain. It is believed that the utility of the wiki lies in its providing a starting point from which a research student can explore research methodology structure and does provide beneficial value in the learning and teaching of such structures, often through the provision of examples. Additionally, it can help prevent novice researchers from using entirely inappropriate philosophical world views, research designs and methods when structuring their own research. There is, thus, a place for such a wiki, even though time and effort will be required to understand how the parts fit together, which may limit its use by those seeking a simpler solution to the problems surrounding the learning and teaching of research methodology.

6 Conclusion

The research methodology semantic wiki considered here sought to provide a platform addressing the "lack of shared language describing important foundational concepts of research methodology" [5, p. 230] using the affordances provided by the Semantic Web. The Semantic Web can be seen as a smart learning environment, and although it is not yet recognised by the NMC Horizon Report [30, p. 36] as one of the enabling technologies that will transform what can be expected of online tools, it has a place in the provision of learning content in online teaching environments. The research contributes to the organising of digital strategies in higher education that "transcend conventional ideas to create something that feels new, meaningful, and 21st-century" [30], which does not, however, mean that success is guaranteed.

The contribution of this work, then, is an implemented and evaluated conceptual model, expressed in a semantic wiki, that can provide a basis for new ideas for online learning of the structure of research methodologies.

There are several ways in which this research can be extended, such as broadening the scope of the initial conceptual model to include a model for research question types, alternative ways of categorising research designs, and broadening of the scope to disciplines beyond computing.

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Enhancing the Quality of Essays Through a Student Peer-Review Process

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Abstract. Peer review and peer feedback is a mechanism that can have a positive effect on the quality of assignment essays. Reviewers need an education on what is a good review and how to conduct a review. A peer review process was implemented at a fourth-year information and cyber security module. The process did not result in any significant higher quality essays. This study evaluates the process as well as the results to determine what lessons can be learned from the process. The study highlights the importance of a strong correlation between the mark rubric and the list of identified characteristics of a good essay. The study strengthens the fact that student reviewers need to be educated in the review process and review aspects.

Keywords: Peer review · Peer assessment · Peer feedback · Effective learning

1 Introduction

The use of assignment essays is a well-known method to evaluate and test a student's ability to construct a process and product [1, 2]. Assignment essays fall in the category of deep approach, where the focus is on an understanding instead of memorization [3]. Industry expects computer science or computer engineer graduates to have the ability to generate quality reports or scientific papers [4]. Peer review and peer feedback is a well-established method to enhance the quality of essays [5]. This paper describes the results of a peer review process that was implemented in the information and cyber security module for fourth year students.

Fourth year students at the University of Johannesburg at the Academy of Computer Science and Software Engineering (ACSSE) department are expected to do literature studies on several topics and create an assignment essay for the relevant topic. The essays count a significant portion towards their semester marks.

Before the student's fourth year, students doing their studies in the department might have had only one opportunity of submitting an assignment essay. Most of the student's previous work and experience comprised of theoretical class work and practical lab work. The little exposure to essay writing means that students may find the process of producing the essay a challenge. This problem is highlighted by other studies [4].

A significant change to the way in which assignment essays are managed was made in one of the fourth-year modules. The change was to see if the students could produce

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 459–468, 2019.
https://doi.org/10.1007/978-3-030-35343-8_49

better quality essays. The change involved a process of introducing the students to the characteristics of a good essay. With an understanding of what comprises a good quality essay, students were expected to produce an essay and then allowing students to peer review each other's work. Students had the opportunity of updating their essays before submitting their final version for assessment.

The objective of this paper is to share the process that was followed, but also to produce a list of lessons learned from the process.

The rest of the paper is organized as follow: Sect. 2 provides a background on the use of peer review for creating better quality essays. Section 3 describes how the peer review process was implemented at the university for the Information and Cyber security module. Section 4 described the methodology that was followed to produce a list of lessons that was learned. Section 5 discusses the results from the study and produces a list of lessons learned. Section 6 reflects on the whole process of the study and highlights areas that requires further research.

The use of essays for a deep learning approach as well as peer review in this process is well documented. The next section provides background on the use of essays in teaching and learning and then extending the process of generating essays using peer reviews.

2 Background

The act of writing is a powerful tool in constructing knowledge [6]. Tynjälä [7] states that university studies can develop expert knowledge through reading, writing and practical exercise. One of the activities in the reading and writing paradigm is the creation of essays from a literature study [7]. The objective of this section is to highlight the problems experienced by students in writing an assignment essay and how peer review activities are used to address the problems.

Students should have a deep level approach to essay writing, unfortunately studies have shown that students do not always understand what is required which results in a surface approach [2, 8]. A deep approach is defined as the intention of the student to understand the ideas. A surface approach is defined where the intention of the student is to cope with course requirements [9].

One of the techniques used by educators to promote a deep approach to essay writing is using peer reviews, also called peer feedback. Peer reviews give students the opportunity to receive initial feedback, which allow the students an opportunity to reflect. The reflection process allows the student to get a better understanding of where the essay might have been lacking [10].

Peer reviews unfortunately is not a silver bullet. Even though it has been proven that peer reviews may have a positive impact on the quality of essays, this has not always been the case. Peer reviews on its own does not always equate to better quality essays [11, 12]. It is important that students providing the peer reviews understand what is expected of them during the peer review process. Training the students in how to conduct the peer reviews have shown to have a positive effect on the overall peer review process.

One of the biggest advantages of the peer review process is that both the student giving and receiving the peer review gains from the process. The student providing the peer review learns through the process and in turn provides better quality essays [13].

In the last few years the peer review process has been complimented with computer-based systems [14]. Some of these systems can provide valuable feedback to the author [15]. The use of automated feedback systems allows an educator to provide feedback in large attendance environments. Automated feedback systems however remove the opportunity for the reviewer to also learn.

Peer reviews have been used extensively in English first language or English second language modules with many studies evaluating the effectiveness in these areas. Few studies showed peer review being used in the computer sciences, instead the focus of peer review systems is in the use of artificial intelligence or machine learning in these areas.

A peer review process for essays can have a positive impact on the quality of essays providing proper training is provided to students doing the reviews. The next section describes the process of peer reviews conducted during a fourth-year module in information and cyber security.

3 Overview of the Process

The peer review process followed during the fourth-year module was designed to first educate the reviewers on the process of reviewing as well as the aspects that make up a good essay. This section discusses the three major phases during the assignment schedule. The three main phases were:

- The peer review preparation phase (Sect. 3.1). The focus of this phase was to prepare and teach students the important aspects of an essay and assessing them on these aspects.
- The peer review process (Sect. 3.2). This phase gave the students the opportunity to peer review three anonymous essays.
- Final submission and assessment (Sect. 3.3). After the students received feedback, changes to their essays were allowed before their final submissions. After submission the essays were assessed by the lecturer and an assistant for the module.

3.1 Peer Review Preparation

The focus of the peer review phase is to give students an understanding of what constitutes a good essay. During the preparation for this phase a clear definition and characteristics of what constitutes a good essay was identified. After the characteristics of a well written essay was identified, the students were given an opportunity to study the characteristics. To see if the students studied the characteristics, an assessment of the characteristics were conducted.

Table 1 lists the various aspects identified by three different studies. Lundstrom and Baker [13] used a rubric obtained from Paulus [10]. The rubric identifies six categories. Norton [16] identified various aspects that is both important to students and tutors.

Norton identified the top ten aspects identified by tutors, ordered from most important to less important. This ordering is also reflected in Table 1. Warren created a document for Philosophy students at the University of Wisconsin [17]. Warren's document does not only list the ten aspects of a good paper, the document also provides general advice on how to approach writing an essay.

Table 1. Characteristics of a good essay [13, 16, 17].

Lundstrom & Baker	Norton	Warren
Organization/unity	Answer the question	Own words
Development	Understanding	Clear purpose
Cohesion/coherence	Argument	Organization
Structure	Relevant information	Focused
Vocabulary	Structure/organization	Complete
Mechanics	Evaluation/own views	Clear purpose
	Presentation/style	Substantively correct
	Wide reading	Mechanically correct
	English/spelling	Flow
	Content/knowledge	Creative

There are a lot of depth in each of the characteristics mentioned by the various authors in Table 1. There is also some agreement between the various authors but uses different words to describe the overall characteristic. Example: Lundstrom and Baker mentions Organization/unity while Norton mentions the same characteristic but calls it Structure. Warren also uses the same meaning for Organization as Lundstrom and Baker.

To minimize confusion for students, the document from Warren was used to define the characteristics of a good essay. The document from Warren also provided particularly good guidance to students on how to approach writing an essay. The Warren document was made available to students to study.

The next aspect in preparing the students for the peer review process was for the students to peer review two historical papers. The two papers selected was historically submitted to conferences on the EasyChair conferencing system [18]. The first paper was an anonymized paper that received generally negative reviews from past reviewers. The second paper was also an anonymized paper which received extremely positive reviews from past reviewers.

The students were assessed in their reviewing capabilities by using a Blackboard assessment. The assessment questions made use of both short answer questions, essay questions and Likert scale questions. The grading of the assessment was automated as much as possible to minimize the feedback time given to students. All the questions were related to the characteristics listed by Warren [17], except for the last question which asked the students to write a general review for the paper. The students were expected to incorporate a summary, the positive and negative aspects if the paper in their review. The assessment of the papers was separated by a two-week period to give the students time to reflect on the review as well as the feedback from the module lecturer on their ability to review.

The outcome of the assessment phase was to see if students could identify the characteristics or lack thereof in the two papers. After the identification of the characteristics of a good essay and the assessment thereof, the peer review process of their own assignment essays started.

3.2 The Peer Review Process

To accommodate the peer review process, a virtual conference called UJIS2019 was created on EasyChair, the online conferencing management system. Proper permission was first obtained from the EasyChair administrators to make use of EasyChair for this purpose.

The UJIS2019 conference was configured in EasyChair for anonymous submissions and the reviewing template was modified to reflect the characteristics identified in the previous section. As with the assessment session, the last question on the UJIS2019 EasyChair conference review template asked the students for a detailed review.

The assignment essay asked the students to write a position paper on the problems, affects and solutions of password reuse. The only mandatory aspect that students had to discuss was a proposal for a unique solution that will address the problem of password reuse. The students were given a few aspects of password reuse to consider while researching content for the essay.

The students were asked to complete the essays on the template defined by Springer Proceeding Template [19]. The reason for using this specific template is that it is a generally accepted template for scientific writing in the field of computer science and it assists students in addressing the mechanical correctness of the essays.

The students uploaded the anonymous essays to the UJIS2019 virtual conference. After the deadline for the submissions all the students were invited as reviewers to the UJIS2019 virtual conference using the EasyChair functionality. Students had one week to accept the invitations. Each student reviewer was configured to conflict with their own essay. This ensured that a student would not accidentally be assigned their own paper to review.

The automatic reviewer assignment feature was used to assign three reviewers per essay. This meant that each student was responsible for reviewing three essays. A deadline of three weeks was given for the review process. After the review process the last phase of the process started, which was the final submission and evaluation.

3.3 Final Submission and Assessment

After the review deadline, the reviews were made available to all the students. The students were given one week to modify their essays and submit their final essays to the department's online submissions system.

The final assessment of the essays was evenly split between the lecturer and an assistant. The mark rubric did not ask the lecturer or assistant to evaluate the essays against the characteristics that was defined during the initial phase of the review process. The mark rubric was kept the same as previous years. This ensured that historical and current essays would be marked using the same basic criteria.

The rubric used defined that each essay must have a proper introduction, a section, or sections where specific themes of the essay were discussed, a specific section where the mandatory aspect was discussed. Other important aspects such as a conclusion, the structure and the number and quality of references were also included in the rubric. Students were penalized for submitting either essays that were too short or too long. The rubric did not provide an exact one-to-one match against the characteristics identified earlier in the study, the examiners were asked to incorporate the characteristics while assessing the essays, where possible.

After the submission and evaluation phase, the marks were captured. The next section describes the methodology that was used to identify a set of lessons that can be learned from the study.

4 Methodology

The objective of the study is to learn from the process and see what can be done better. The methodology that was followed during the study was to first evaluate some basic data characteristics of the 2019, 2018 and 2017 assignment marks. The next major step was a reflective analysis of the peer review process and a basic qualitative analysis of the 2019 results.

To better understand the limitations of the data characteristics, differences between the 2019, 2018 and 2017 marks are discussed: In 2017 and 2018 the module lecturer used an approach that allowed students to complete two assignment essays for the module instead of just one. Because the module was one of the first assignment essays that most of the students were asked to complete, the module lecturer allowed students to complete the first assignment essay, receive results back and then complete a second assignment if they wished. The assignment with the best marks were used for their semester marks. Students could also decide to only complete the second assignment, with the understanding that they would not get a second opportunity. For the sake of this study only the first assignment statistics were considered because this provides a better reflection between 2019, 2018 and 2017 students writing their first assignment essay.

Table 2 provides some basic statistics highlighting the differences between the three years. 2019 had the most students completing their first-time assignments, with 2017 the least number of students. Between the three data sets, 2019 also had the highest failure percentage, with 2017 the highest pass percentage. The mean of 2019 and 2018 was nearly identical. In fact, it seems as if 2019 and 2018 results were similar, with 2019 slightly worse results.

The qualitative analysis evaluated the ten lowest 2019 marks. The qualitative analysis asked four questions to see if something could be learned from the worst performing students. The questions are:

1. What was the quality of the feedback given to the student?
2. Did the student make a significant change, given the input from the feedback?

3. A generalized comment of whether the student was given good feedback and whether the feedback influenced the final essay.
4. Is it purely the fault of the author or did the reviewers not provide good enough feedback?

Table 2. Basic results.

	2019	2018	2017
N	82	75	56
Failed%	15%	13%	2%
Passed%	85%	87%	98%
Mean	65.58	65.03	73.05
N failed	12	10	1
N passed	70	65	55

To analyze the ***first question***, a value of one was given for each reviewer that provided good quality feedback. Quality feedback is defined as feedback that closely correlates with the feedback the module lecturer might have given to the student. A numerical value (0–3) describing the number of quality reviews was established for each essay.

To answer the ***second question***, the differences between the EasyChair submission and the final submission was evaluated. Values between zero and two were given to describe the changes made by the student. A value of zero means the student ignored the feedback and no changes were made between the initial submission to EasyChair and the final. A value of one means little changes were made and a value of two means there was a significant difference between the initial and final submissions.

The ***third question*** provide comments on whether the author used the opportunity to make changes to the final essay. The ***last question*** tries to establish whether the author had enough feedback to make the changes or whether author ignored the feedback. A value showing 'reviewer' means that the reviewers did not give enough feedback so that the student could make relevant changes. A value showing 'author' shows that enough feedback was given, but the author did not use the opportunity. In cases where not enough feedback was given and the author ignored the little feedback given, both 'author' and 'reviewer' is listed.

Table 3 provides the results of the qualitative analysis completed on the bottom ten student marks for 2019. A discussion of these results is found in the next section.

5 Discussion and Lessons Learned

In the previous section the methodology is described to interpret the results from using a peer review system to try and increase the quality of research assignments. Comparing the 2019 results in Table 2 with the 2018 and 2017 results does not show any significant increase. It may even be said that 2019 results may have been even worse than the other years, specifically looking at the percentage pass rate.

Table 3. Analysis of the bottom ten marks.

Feedback quality	Updated	Comments	Problematic aspect
2	1	None of the reviewers specifically commented on the lack of completeness of the paper	Reviewer
2	1	Despite the reviewer feedback the final version was still only three pages long, which in an incomplete paper and suffered a length penalty	Author
1	2	Despite the reviewer feedback the final version grew from 3 to 5 pages, which resulted in an incomplete paper and suffered a length penalty	Author
1	1	The paper suffered from structure, focus and flow problems. This was strongly highlighted by one reviewer, but other reviewers did not highlight this enough	Reviewer
3	1	Quality, focus and structure were major stumbling blocks. Feedback was mostly ignored	Author
1	1	Only one reviewer commented on the poor layout and flow problems. Some clarity issues were highlighted but ignored	Reviewer
3	2	This student submitted only half of the final essay. This means the final paper could not benefit from a proper peer-review	Author
1	2	The paper suffered from poor English. Most of the paper was not understandable. Reviewers also gave conflicting reviews	Reviewer \Author
1	2	Changes were made to the essay, but the reviews did not highlight the major flaws in the essay	Reviewer
3	1	Very little was updated given the reviews	Author

There is a closer relationship between the 2019 and 2018 results than with the 2017 results. The 2019 results had the highest number of submissions. The 2019 mean was slightly higher than the 2018 mean, even though the number and percentage students that failed the essay was more than 2018. An aspect that may have played a big role in the results may have been the 2018 and 2017 process which allowed students a second chance to resubmit. The second chance submission may have attracted some students to only use the second submission opportunity thereby not including them in the data sets for 2018 and 2017.

While evaluating the bottom ten marks in 2019, Table 3 shows that half of the students received poor quality reviews that may not have given them the opportunity to increase the quality of the essays. The other half showed an inability of the authors to use the feedback provided to them to significantly increase the quality of the essays.

The fact that half of bottom reviews were of poor quality is a concern. The poor reviews may even have had an inverse effect on the quality of essays. The students received reviews showing them little problems and assumed they had a good quality essay. This may have created a false sense of accomplishment. Students may only have realized the problems in their essays after they received the feedback from the marked rubric.

The poor-quality essays for the bottom ten essays showed that some students still did not know how to write good quality essays. 12 of the possible 30 reviews for the bottom ten essays were of poor quality and did not add any value to the process. Upon reflection the lessons that was learned during the process may be summarized into the following list:

1. A new list that combines the ten characteristics from Warren [17] and the aspects in the mark rubric needs to be created. This new list should form the basis that is used to teach students how to write a good quality essay and should form the basis of the mark rubric.
2. The two assessments where students had to review both a good and bad essay may be consolidated into only one theoretical assessment and one application assessment.
3. The review template in EasyChair needs a closer reflection of the rubric aligned list of characteristics.
4. The period to apply the feedback from reviews may be increased to give students a better opportunity to apply the changes.
5. The process used in 2018 and 2017 may need to be reconsidered since it resulted in overall higher quality essays.

The results from the study and the lessons learned requires a reflection on the whole process, but it may also highlight areas for future research.

6 Conclusions

Assignment essays are mechanisms that encourage knowledge creation. A deep learning approach reflects in good quality essays. There is a general lack of understanding by some students what constitute a good quality essay. Peer reviews may assist students in understanding aspects that may be lacking in their essays. Teaching students the aspects of a good quality essays and teaching peer reviewers may be both beneficial to the author as well as reviewer.

The process described in this study did not result in better essays, compared to previous years. The process identified source material that highlighted several characteristics of a good essay. Students were given the source material and the student's ability to apply the characteristics in a review scenario was assessed using Blackboard assessments. Students were given an opportunity to create an initial version of their assignment essay which they uploaded to a virtual conference in EasyChair. Students were invited as reviewers in the EasyChair conference and asked to review another student's essay. After the review process students could make changes to their initial essay and submit a final version for assessment.

The second chance process used in 2018 and 2017 may have been more beneficial for the students. The students had more opportunities to practice their writing and their ability to do a literature study in 2018 and 2017. Even though the second chance process may have been more successful, the next study can evaluate the changes described in the lessons learned.

The process described in this study did not produce better quality assignment essays, but the opportunity was used to learn from the process. A set of lessons learned was defined. A misalignment between the identified essay characteristics taught to students and the mark rubric may have had a negative contribution to the results. The use of EasyChair and Blackboard allowed this study to be concluded with a clearly defined process.

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The Design and Development of Constructivist Web-Based Learning Environment Framework to Enhance Digital Literacy for Higher Education

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Abstract. The purpose of this research was to synthesize theoretical framework and designing framework of web-based learning environment model based on constructivist theory to enhance Digital Literacy skill. The research was documentary research. The procedures were as following: (1) To examine and analyze the principles and theories (2) To review relevant literature (3) To explore the context concerning (4) To synthesize theoretical framework and designing framework of constructivist web-based learning environment. Using the framework of digital literacy, UNESCO (2011) as following on three principles: (1) the skills and knowledge to use a variety of digital media; (2) the ability to critically understand digital media content and applications; and (3) the knowledge and capacity to create (content) with digital technology. The result revealed that: Constructivist web-based learning environment comprise of 6 components as following: (1) Learning Task (2) Learning Resource Center (3) Digital Literacy center (4) Cognitive tool (5) Scaffolding center and (6) Coaching center.

Keywords: Constructivist web-based learning · Constructivist theories · Digital literacy · ICT literacy · Library

1 Introduction

Digital literacy involves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive, motor, sociological, and emotional skills, which users need in order to function effectively in digital environments. Importance in higher education. By making sure that students develop critical thinking and ICT skills, and by assisting them in the construction of a framework for lifelong learning, colleges and universities supply a solid base for sustained development throughout their academic and professional careers. IL is an essential part of becoming a lifelong learner (Association of College and Research Libraries 2005). Teaching students to critically assess, evaluate, and use information is now viewed as essential to student success and has become a central component of library instruction. There are numerous studies that speak to how academic librarian can help to increase

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 469–476, 2019.
https://doi.org/10.1007/978-3-030-35343-8_50

Digital Literacy skills among adult learners, and, in so doing, in- crease student retention (ACRL 2005; Chaijaroen 2015; The Partnership for 21st Century Learning 2015).

2 Research Methodology

This research is the first phase of the Model research (Richey and Klein 2007), which focuses on the design process and model development. The process consists of (1) document analysis examine the learning, teaching and context, (2) analyze related principles and theories such as learning theory, Constructivist theory, Cognitive theory, Digital literacy, media theory, and technology, designing of Constructivist web-based learning environment model to enhance Digital Literacy, (3) synthesize the theoretical framework. The participants in this phase included experts from various fields such as theorists, designers, developers, evaluators, researchers, and learners. The Model research on the first phase is the Model development. The data were collected by quantitative and qualitative methods. The document analysis and survey were used.

2.1 Research Objectives

The objective of this research is to design and develop Framework of constructivist web-based learning environment model to enhance Digital Literacy for Higher Education students.

2.2 Literature Review

Constructivism represents one of the big ideas in education. Its implications for how teachers teach and learn to teach are enormous. If our efforts in reforming education for all students are to succeed, then we must focus on students. To date, a focus on student-centered learning may well be the most important contribution of constructivism [Brown et al. 1989]. Constructivism is often compared to objectivism, which is usually quoted as being the counter point or direct opposite of constructivism. Much of objectivist theory is based on the work of behaviorists such as Skinner (1953). Objectivists believe that information itself is knowable outside the bounds of any human mind, and that any individual interpretation of knowledge can be said to be either correct or incorrect. Objectivists view individual pieces of information as symbols or currency that can be acquired by humans, and can be transferred from human to human should the correct learning conditions exist (Jonassen 1999).

2.3 Data Collection Instruments

1. A synthesis of theoretical framework record form for recording the analysis of document and related research.
2. An open-ended survey on students' opinions about the context of learning teaching. Questions are concerned with teaching and studying that can to enhance Digital Literacy.

3. A synthesis designing framework record form for recording the analysis of document and related research for designing the learning environment model.
4. The reviewed record form for checking the quality of the designing framework.
5. An open-ended survey of the participants 'characteristics adapted from Richey and Klein (2007).
6. An interview form for the designer and the developer on the design and development processes of the learning environment model, adapted from Richey and Klein (2007).

2.4 Data Collection

The data were collected as the following details:

1. Document analysis. The researcher reviewed and analyses principles, theories, and previous research studies on the web-based learning environment model, which consisted of a variety of fundamentals such as Psychological base, Pedagogical base, Media theory base, Technological base, and Contextual base. Based on the synthesis of these principles and theories, the theoretical framework for model development was developed.
2. Synthesis of the theoretical framework. The framework was obtained from the analysis of related documents and related researcher as mentioned above.
3. Survey of students' opinions. The students' opinions on learning and teaching context were examined by using open-ended survey on students' opinions about the context of learning teaching.
4. Synthesis of the designing framework, which was based on the theoretical framework and the contextual study of learning and teaching.
5. Exploring of the characteristics of the designers, the developers, instructors and learners by using open-ended survey of the participants' characteristics and the development of the learning environment model by using the interview.

2.5 Data Analysis

1. To obtain the theoretical framework, related principles and theories and documents were analyzed and synthesized by using summarization, interpretation and analytical description.
2. The students' opinions concerned the learning and teaching context from the opinionniare were analyzed by using summarization, interpretation and analytical description.
3. The designing framework was analyzed by using summarization, interpretation and analytical description.
4. The experts' assessment concerning the designing of the learning environment model was analyzed by using summarization, interpretation and analytical description.
5. The characteristics of the participants for designing and developing the web-based learning environment model were analyzed by using summarization, interpretation and analytical description.

3 Results

The results of this study are as follows:

3.1 Theoretical Framework

The results revealed that the theoretical framework consists of 5 fundamental: (1) Psychological base, (2) Pedagogies base, (3) Contextual base, (4) Media Theory and Technological base, and (5) Digital literacy base (see Fig. 1).

3.2 Designing a Framework of Web-Based Learning Environment Model

The designing framework of Constructivist web-based learning environments model to strengthen students' Digital Literacy showed the four stages as follows:

1. The activation of cognitive structure and enhance Digital Literacy. The activation of cognitive structure states the importance of the relationship between different underlined theories, which include Constructivist theories and Cognitive constructivist theory (Piaget 1964), Situated learning (Brown et al. 1989), and Digital Literacy (Martin 2005). It was designed on complex problem context as the component of Problem base.
2. The enhancement of cognitive equilibrium. Four theories must be taken into considerations when designing a web-based learning model to enhancement of cognitive equilibrium. These include Information processing theory (Klausmeier 1985), Meaningful learning theory, SOI Model (Mayer 1999). It was designed as the component of Resources Center. And CLEs (Jonassen 1999). It was designed as the component of Related communities Center.
3. The support and enhancement of cognitive structure and Digital Literacy. To enhancement of cognitive structure and Digital Literacy, the relationship between the following underlined theories must be adopted. These include Social constructivism (Vygotsky 1978) designed as the component of Collaboration Center, OLEs (Hannafin 1999) designed as the component of Cognitive Tools, and Digital Literacy (Martin 2005) designed as the component of Digital Literacy Center.
4. The enhancement and support of knowledge construction and helping of Digital Literacy The relationship between the following underlined theories must be achieved. These include Social constructivism (Vygotsky 1978), OLEs (Hannafin 1999) designed as the component of Scaffolding Center (e.g., conceptual, metacognition, procedural, and strategic scaffolding), and Cognitive apprenticeship (Collin et al. 1991) designed as the component of Coaching Center [Klausmeier 1985; Kozma 1991].

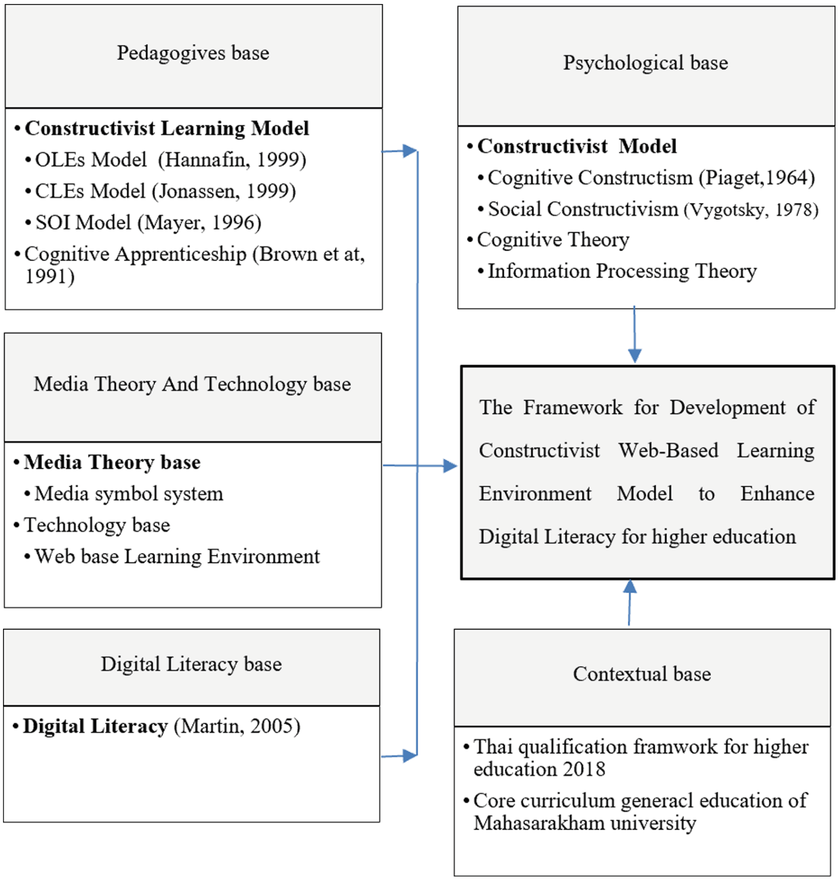

Fig. 1. The Theoretical framework for Development of Constructivist web-based learning environments model to enhance digital literacy for higher education students.

The designing framework on above mentioned four stage in Fig. 2.

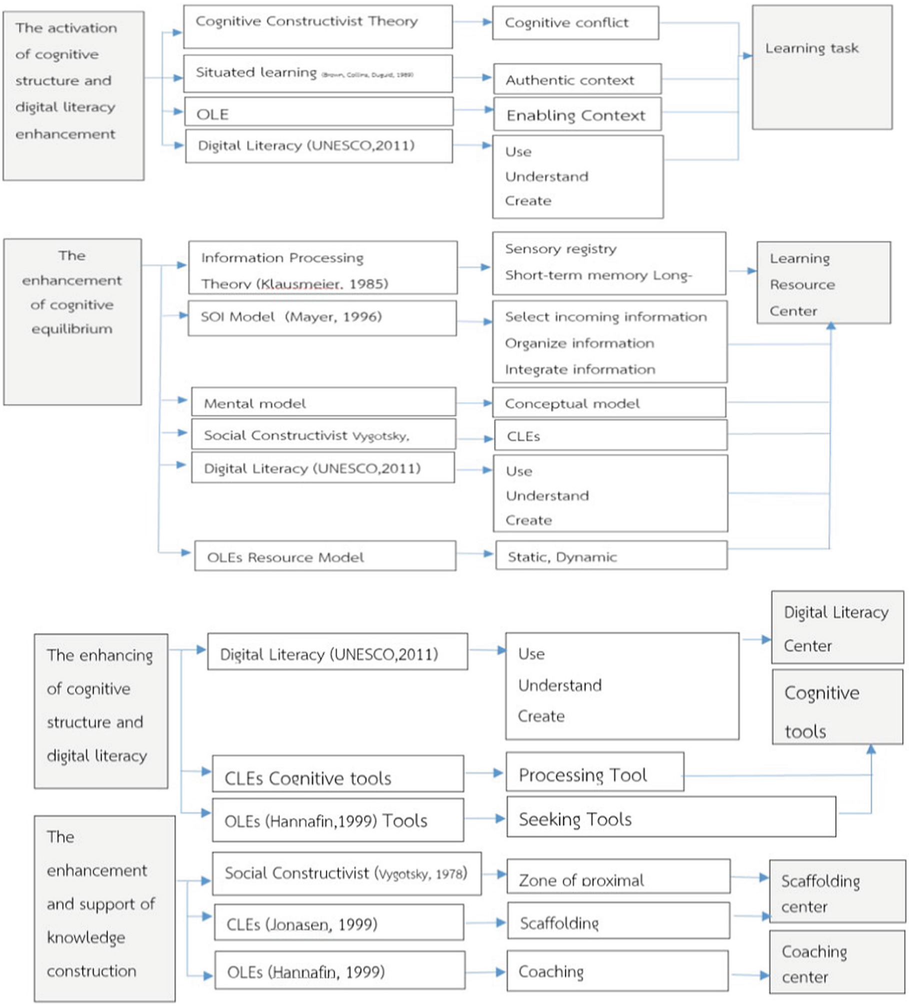

Fig. 2. Design framework for Development of Constructivist web-based learning environments model to enhance digital literacy for higher education students.

4 Discussion

The results of the Framework of the Constructivist web-based learning environment to enhance Digital Literacy for model students consists include (1) Psychological base, (2) Pedagogical base, (3) Contextual base, (4) Media Theory and Technology base, and (5) Digital Literacy base, and four stages of The designing framework as followings: (1) The activation of cognitive structure and enhance digital literacy, (2) The enhancement of cognitive equilibrium, (3) The support and enhancement of cognitive structure and digital literacy, (4) The enhancement and support of knowledge construction and helping of digital literacy including 6 elements as following: (1) Learning task, (2) Learning resources Center, (3) Digital literacy Center, (4) Cognitive tools, (5) Scaffolding Center, and (6) Coaching Center. The findings of this study shed light into the field related to learning environments to enhance students' Digital Literacy. ICT or digital literacy frameworks have been developed in the last ten years, in the hope that they would empower educators to not only master technology and integrate it, but ultimately transform learning and teaching. However, experience has shown that using ICT Is not enough to bring about significant changes. Very often, it has been assumed that if teachers are equipped and connected then using the tools will bring with it the know how for using them. The ICT or digital literacy frameworks that have been deployed in education [Martin 2008].

5 Conclusion

The purposes of this study were to design and develop Framework of Constructivist web-based learning environment model to enhance digital literacy for higher education students. The theory foundations for the design of model consisted of psychological and learning theory, instructional design theory, communication and message design theory and design and development research. It was synthesized as theoretical framework and learning context as basis in designing framework associating the design elements of the model. of the Framework of the Constructivist web-based learning environment to enhance Digital literacy for higher education students.

Acknowledgements. This research was supported by Ph.D. Program in Educational Technology, Faculty of Education, Research Group for Innovation and Cognitive Technology, Khon Kaen, University, and Research and Technology Transfer Affairs Division, Khon Kaen University which hereby giving the thankfulness all through this.

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Cyber Safety Awareness – Through the Lens of 21st Century Learning Skills and Game-Based Learning

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Abstract. The decrease in the cost of ICT devices has seen a steady increase in ICT users connecting to cyberspace. The number of cyber users has increased over the years and across the globe. One group of cyber users that actively participates in cyberspace are the youth (school learners) that use cyberspace or education and socializing. However, school learners do not have the required cyber safety awareness, skills and knowledge to protect themselves and their information in cyberspace. These cyber users participate on social media sites, on instant messaging forums and use the web to gather information. Being a cyber user has numerous advantages for any cyber user. However, these cyber users are also exposed to a wide range of cyber dangers within cyberspace. It is therefore vital that all cyber users in cyberspace be aware of various negative cyber incidents that can occur. Examples of such incidents include identity theft, hacking, sexting and the receiving of unwanted material. It is therefore vital that all cyber users be aware of the cyber risks and threats and know how to address or avoid a cyber threat. This research aims to (1) identify different building blocks that are needed to establish and grow a cyber safety culture in South Africa, (2) identify the different cyber safety topics to include in the cyber safety curriculum, (3) identify the 21st century learning skills that underpin cyber safety awareness, education, knowledge and skills development, and lastly, (4) provide a presentation method for a cyber safety approach.

Keywords: Cyber users · 21st century learning skills · Game based approach · Cyber safety awareness

1 Introduction

Information communication technology (ICT) has developed over time to be an integrated part of society and is used for business, socializing, information gathering and education. ICT users are using ICT devices (mobile phones, desktops and tablets) to connect cyber users via the internet (cyberspace). Almost half of the world population has access to and uses ICT devices [1]. Access to cyberspace allows cyber users connectivity to a wide range of functionalities, for example e-mails, social media sites, internet banking, search facilities and information-gathering tools [2]. Advantages of cyberspace include instant connectivity across the globe, growing business opportunities and enriched education. However, the positive impact of cyberspace is often overshadowed by cyber risks and threats [3–5].

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 477–485, 2019.
https://doi.org/10.1007/978-3-030-35343-8_51

Cyberspace has no geographical boundaries and therefore cyber risks and threats are not contained within one confined country or region. Cyberspace is a global network with more than one billion websites with an estimated 3.5 billion users in more than 200 countries [6]. Being a cyber user and being connected to cyberspace has a number of advantages that can enrich people's work and personal environment; however, the disadvantages of cyber use can overshadow the advantages.

According to Symantec, in 2016, 689 million people in 21 countries were the victims of cybercrime [7]. Cyber risks and threats can have dire implications for all cyber users and can include identity theft, phishing, cyber bullying and sexting, to mention but a few. All cyber users can become cyber victims and non-technical cyber users are a group of cyber users that have limited or no awareness, knowledge or skills to protect themselves (and their information) in cyberspace. Developed countries, for example the USA and the UK, have already implemented relevant and important cyber safety countermeasures in an attempt to assist school learners to protect themselves and their information in cyberspace. These cyber users are thus educated from a young age regarding cyber safety.

However, in developing countries like South Africa this development lags behind. Currently South Africa (identified as a developing country) has no cyber safety education included in the school curriculum. Teachers are ill equipped to address cyber safety risks and schools are unaware of their role and responsibility to ensure school learners are cyber safe [8, 9].

This research paper focuses on how cyber safety can be incorporated into a curriculum design process to assist learners to become responsible digital citizens in the 4th Industrial Revolution.

2 Background

It is estimated that 85% of the jobs that will exist in 2030 have not yet been invented [10] and most of these "futuristic" jobs will be driven by technology [11]. Information communication technology (ICT) is thus the future of the world, development, communication and society. All industries, government sectors and private businesses are being industrialized and connected to ICT in one way or another. The world revolves around ICT, ICT devices and connectivity to the internet especially the Internet of Things (IoT) [12]. The IoT currently consists of 23 billion devices connected to the internet and is estimated to grow to 75 billion in 2025 [13]. Currently there are more IoT devices than humans on earth. Connectivity of ICT, ICT devices and the internet is more than just the norm for businesses and private use, it has become a lifeline of necessity for business and education, and has become a way of life.

This growth in ICT technology and devices is the basis of the 4th Industrial Revolution. The term "4th IR" was first coined by Prof. Klaus Schwab in 2016 during the World Economic Forum held in Davos. The 4th IR is seen as a reality where technology and humans merge on a different integration level. According to Schwab, the world is not prepared for the change in technology and interaction with humans.

It is therefore, vital and essential to ensure that ICTs, ICT devices and the use of ICTs form an integral part of teaching and learning within any educational environment to prepare learners to become part of the workforce in a technology paradigm within the next 10 to 20 years. All learners currently within any school system are preparing for an unknown job within the ICT sphere and a technology-driven environment. It is therefore essential that ICT forms the foundation of the educational process and is integrated in the teaching and learning of all school learners to ensure that all learners are prepared for a future in ICT. ICT education must evolve to adapt to new technologies and new teaching pedagogies; teachers must be better prepared to teach with ICT and use it as an educational tool; and thus, the learning methods must be adapted to integrate ICT which should not be a stand-alone add-on in the educational learning process. One aspect of ICT education is ICT and cyber safety. All school learners must learn how to protect themselves and their information.

Currently South Africa (as well as many other African developing countries) has no strategy in place to establish and grow a cyber-safety awareness culture in the schools. South Africa has not yet set up an ICT and cyber safety curriculum within the school system, and individual schools have only limited policies and procedures in place. This research will focus on what building blocks, cyber safety topics and educational approaches are needed and can be used and incorporated to establish a cyber safety paradigm in South African schools.

3 Methodology

The research used a mixed methods approach (interpretive qualitative and quantitative), underpinned by interpretivism, to obtain data for this research study. The main focus was to obtain personal feedback from the participants regarding their viewpoints on the current state of cyber safety in South Africa and to find out what they would suggest and advise on how to improve the cyber safety culture. The data was gathered during a cyber safety conference that was attended by participants from the government, education and organizational sectors in South Africa. A think tank approach was used to obtain data quality and quantitative data regarding the current cyber safety situation in South Africa. The following process was followed:

- Three speakers - one from academia, one from industry and one from the educational sector - presented a brief introduction on “Cyber Safety Awareness: The current Situation within South Africa”.
- A brief explanation of the think tank discussion was given.
- A questionnaire consisting of 15 questions was distributed to each delegate in the conference room and the delegates were asked to complete the questionnaire.
- The participants were divided into five groups who gathered in five different spaces in the conference room. Each space had a scribe and a leader that conducted the discussions. The discussions revolved around five questions/statements at each of the five different discussion stations.
- Conclusion message to the conference delegates about the think tank.

Fifty (50) participants participated in the think tank discussions and 23 participants completed the questionnaire.

4 Data Analysis

The data analysis included the analysis of the completed surveys as well as the feedback from the think tank discussions. The discussions were recorded and transcribed. Both the surveys and the transcriptions were used in the analysis. The analysis of the data focused on (1) identifying different building blocks that are needed to establish and grow a cyber safety culture in South Africa, (2) identifying the different cyber safety topics which should be included in a cyber safety curriculum, (3) identifying the 21st century learning skills that underpin cyber safety awareness, education, knowledge and skills development, and lastly, (4) providing a presentation method for a cyber safety approach.

4.1 Direct Feedback from Participants

The participants were requested to indicate their personal opinion regarding cyber safety in South Africa. Some of the feedback from the participants is indicated below.

The following direct quotes were captured from the participation surveys:

- "It (cyber safety) is the responsibility of everyone in South Africa."
- "Schools must have a cyber-safety curriculum."
- "Mandatory introduction regarding cyber-safety into basic education via curriculum."
- "Improvement in digital literacy across South Africa and in all communities."
- "Cyber safety must be addressed on national level with a special focus on school learners."
- "Cyber safety awareness must be fun for the kids".
- "Future of cyber safety within South Africa should be multidisciplinary".
- "School must be at the forefront of cyber safety for children".
- "Improving of e-skills and e-safety through basic ICT knowledge."
- "Cyber safety in South Africa must follow a systematic approach."
- "Cyber safety is the responsibility of EVERONE."
- "Community approach is critical to grow a cyber-safety culture."
- "Buy-in from government and educational department."
- "Cyber safety should be funded to implement properly."
- "Inclusion of 21st century learning skills, in order to understand cyber safety."
- "Cyber safety is also about critical thinking and responsibility."
- "Prepare children for a ICT future."

All the feedback that was obtained by the surveys was analysed and grouped according to the emerging building blocks and sub-themes.

4.2 Cyber Safety Building Blocks

The following building blocks and sub-themes related to cyber safety education and school learners were identified through the data analysis (surveys and think tank session):

Building. block 1: Creation of a cyber safety culture in schools.
Sub-themes: Governmental approach through policies
Procedure to establish and grow cyber safety culture
Africanization
Language specific

Building block 2: Educational intervention.
Sub-themes: Schools
Universities
Department of Education (on national level)
Grow cyber safety community

Building block: 3 Information dissemination.
Sub-themes: Needs-based analysis
Broad and diverse involvement
Dissolve silo approach
Instill integration approach

Building block 4: Empowerment of role players and communities.
Sub-themes: Long/short-term approach
Once-off /continued approach
Government, parents, schools, teachers, industry and learners
Support and networking between role players

Building block 5: Capacity building for school learners.
Sub-themes: Skills development
Knowledge creation
Relevant training
Growing awareness

Building block 7: Integration into educational approached (paradigm).
Sub-themes: 4th Industrial Revolution
21st century learning skill
Paradigm integration
Cyber safety curriculum

Building block 8: Curriculum development.
Sub-themes: Fun activities
Integration into real-life scenarios
Must be collaborative approach
Social interactive approach
Games-based approach

These eight building blocks provide a framework that can be used to guide a school ICT and cyber safety curriculum. One aspect that was mentioned in building block 7 that is critical is the inclusion of 21^{st} century learning skills.

4.3 21^{st} Century Learning Skills

In building block 7, 21^{st} century learning skills were identified as a “lens” that must be used when creating cyber safety educational material to enhance cyber safety knowledge and skills. The following six 21^{st} century learning skills were identified as a basis for cyber safety awareness:

- Critical thinking
- Collaboration
- Communication
- Information literacy
- Technology literacy
- Social skills

It is critical that these six skills be taken into account when cyber safety curriculums are designed and implemented. The data analysis showed that one way of incorporating cyber safety in the curriculum could be via games-based learning underpinned by a collaborative learning approach.

4.4 Cyber Safety Topics Identified by Participants

The following cyber safety topics were identified that need to be integrated into an ICT and cyber safety curriculum:

- Cyber bullying
- Sexting
- Social etiquette
- Texting
- Unwanted communication
- Digital citizenship
- Digital footprint
- Legal use of material
- Cyber identity
- Cyber extortion
- Fear of missing out
- Negative impact of cyber safety

It is vital that all school learners understand these cyber-related topics to ensure their safety in the cyber environment.

5 Example of Games-Based Learning

There are 11 official languages in South Africa, and this should be taken into consideration when creating a games-based approach for schools [14]. Game based learning have been proved to enhance the educational environment [15–17]. It must be possible to translate all the games into the different languages [18]. One example of a games-based learning approach is depicted in Fig. 1.

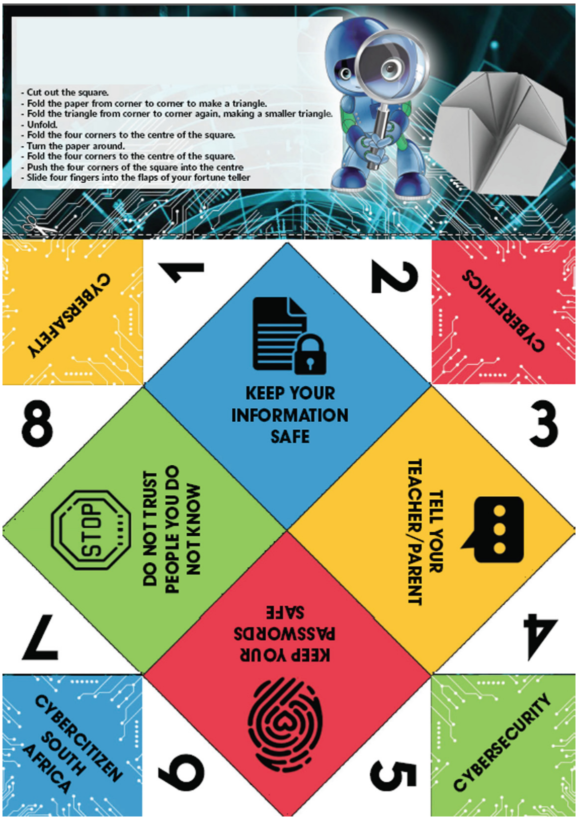

Fig. 1. Cyber safety game for learners

The game depicted in Fig. 1 can easily be translated into different languages. This game provides an entrance-level discussion point whereby cyber safety is introduced to school learners in a fun and collaborative way. This game will be for an introduction learning environment to introduce basic term for example Cyber ethics and Cyber citizenship with 4 key actions for novice cyber users.

6 Conclusion

Cyber safety awareness, education, knowledge and skills should form part of the school curriculum in order to ensure that all school learners learn how to protect themselves and their information in cyberspace. Currently, developing countries such as South Africa have a huge task ahead of them to ensure that cyber safety is included in the school curriculum. Teachers and parents need to be empowered to assist school learners in becoming responsible digital citizens so that they can contribute to growing a national cyber safety culture. The research study found that cyber safety topics should be included in the school curriculum and could be introduced by using 21st century learning skills and a games-based approach. The research proposed an introductory game that can be easily translated into all 11 South African languages and can be used in a collaborative environment to introduce a few cyber safety related topics.

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A Systematic Literature Review of Qualitative Gamification Studies in Higher Education

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Abstract. Gamification can heighten student motivation and make learning more engaging. Several literature reviews focus on the effects of gamification; however, no work to date has been done that exclusively examine qualitative studies in higher education. In this paper, we systematically review existing literature on gamification in Information Systems (IS) research to identify qualitative topics studied. We synthesise relevant studies with the concept of an information ecology to show how important sociocultural dimensions and participatory design are for sustainable and successful gamification in higher education. We deploy Hermeneutics as a theoretical lens. The hermeneutic circle, in particular, allows us to understand a complex 'whole' of a gamification information ecology from presuppositions about the sociocultural dimensions of its 'parts', and their interconnectedness. The paper furthermore argues for iterative methodologies to assist designers, practitioners and users to co-evolve towards a sustainable gamification solution. Iterative methodologies typically take highly participatory and cyclic approaches that allow stakeholders to systematically investigate and develop effective and sustainable solutions.

Keywords: Gamification · Information ecology · Information systems

1 Introduction

Werbach defines gamification as "the process of making activities more game-like" [1]. Gamification practitioners typically extract game elements (e.g. points, badges, leaderboards) customarily found in digital games, and transfer them to education, business and health contexts to increase user engagement with certain underlying activities [2]. In IS education, and education in general, the primary purpose of gamification is to foster similar engagement and motivation which game players have towards games in learners and their approach to classroom learning [3]. We seek to advance our understanding of gamified learning by systematically reviewing gamification related research in Information Systems (IS). We frame this review within the concept of an information ecology. An information ecology is "a system of people, practices, values, and technologies in a particular local environment" [4].

The original version of this chapter was revised: corrections, which were not incorporated during the proofing stage due to a technical error, were incorporated. The correction to this chapter is available at https://doi.org/10.1007/978-3-030-35343-8_90

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 486–497, 2019.
https://doi.org/10.1007/978-3-030-35343-8_52

This paper focuses only on IS studies that used qualitative research methods to gamify educational information systems. The reason behind this is to illuminate user experience. Qualitative research tends to focus on social, cultural and subjective experiences [5]. We proceed as follows: In the following section, we justify the systematic review of only qualitative gamification studies. We then discuss Hermeneutics – the theoretical framework of this paper. We proceed with a systematic review of qualitative studies of gamification in higher education.

2 Background

2.1 Information Systems as an Organisation Function and a Scientific Discipline

To justify the systematic review of only qualitative gamification studies in IS education, we start by defining the term 'information systems' to provide a clear target for the systematic review related to IS studies. There is a lack of consensus on the meaning of the term information systems, both as an organisation function and as a science. Lee [6] finds the interchangeable use of the term information systems with other similar terms problematic. Information and communication technology (ICT), for example, is often used synonymously with information systems where both terms refer to 'the computer'.

For Lee, views that overemphasise the 'technical' are incomplete because they seem indifferent to reciprocal transformational exchange that unfolds between technical systems (i.e., ICTs) and social systems (i.e., users and organisations). According to Lee, this transformational interactive relationship denotes information systems as an organisation function. Similar to how information requirements of a social system inform a technical system, there are user needs that the technical systems require to support the social system. Following the design and implementation of a technical system to avail information to the social system, the technical system itself would be altered. The altered state would instigate new and different user needs for the social system to satisfy.

Lee's [6] description of the dynamism of an information system lays common ground for the topic of information ecosystems. If one considers the specifications Nardi and O'Day [4] attribute to information ecosystems, information ecosystems and information systems share an array of convergent theories and practices. In light of the above, we assert that for a gamification system to satisfy students' learning needs, new learning goal requirements might emerge for the gamification technology to fulfil. Thus, research needs to incorporate student views, attitudes and perceptions in a local context to meet learning needs via gamification. By considering the nature of qualitative research, we advocate the use of its underlying epistemological principles to examine student needs to support an effective gamification system and vice versa.

In light of the preceding discussion, the term 'information' suggests that it cannot be compartmentalised as either the technology or the social system [6]. Lee [6] suggests a third system, namely the 'knowledge system', to be added to the technology and social system. In terms of the properties, behaviour and design of a knowledge system, researchers can choose from a wide selection of bodies of knowledge, which include Sociology, Phenomenology or Hermeneutics, among many others. These bodies of knowledge typically focus on the interpretation of social phenomena [6].

Sociocultural and contextual aspects are indeed pertinent in the play of games. Prior learning experiences, for example, can affect player performance, depending on when and where they learned to play a game, as well as the number of times they have played the game before [7].

2.2 Methodological Deficiencies in Gamification Research

The pertinence of gamification in IS is apparent given that most gamification strategies will involve the development or use of an information system. IS is regarded as an interdisciplinary field [8]; by implication, researchers consult methods distinct to both the natural and social sciences to study gamification [3]. Most studies explore gamification via post-positivist methods [9], which are typically located within the natural sciences [10]. In terms of post-positivism, science is viewed as not certain but dependent on many contingencies; post-positivists explore these contingencies to comprehend social reality better [11].

Post-positivists argue that science can suggest rational hypothesising about a phenomenon by joining logical reasoning with empirical observation [11]. This approach advocates methodological pluralism, i.e., both quantitative and qualitative methods are used. While positivists believe objective reality can be captured and understood, post-positivists argue that truth can never be discovered; evidence is always fallible. Similar to positivists, post-positivists formulate a hypothesis from theory and seek a causal relationship using experimentation and correlational studies. However, with the data collected, post-positivists either support or refute a theory which is then followed by revisions and additional tests [5].

Post-positivists furthermore argue for the inclusion of participants' multiple perspectives [12]; hence they – similar to mixed methodologists – will additionally use qualitative research methods such as interviews to build on their results. Post-positivism and mixed-method research differ insofar as post-positivists use quantitative methods to analyse qualitative data. For instance, content analysis is harnessed to quantify thematic descriptions via frequency rates [13]. This is why Creswell [5] does not consider post-positivism as a philosophical tradition in its own right, but merely as an extension of positivism because its assumptions are more orientated towards quantitative research than qualitative research.

As an example, results from the experiments that Hamari [14], Cheong, Cheong and Filippou [15] and Nehring, Baghaei and Dacey [16] conducted show that the implementation of digital game elements improves student performance. Conversely, Domínguez et al. [17] and Frost, Matta and Macivor [18] – also using experiments – report that a digital gamification strategy did not affect student performance. In light of these incongruent results, Vermeulen, Gain and Marais state that "the fact … that we expect players to behave as we intend, suggests that our assumptions are flawed" [19].

Post-positivists furthermore seek reproducibility of results to generalise findings (external validity) to a larger population [5]. In a gamification context, this principle is rejected by Bogost [20], who questions the anticipated reproducibility of game elements: "This rhetorical power derives from the "-ification" rather than from the "game". -ification involves simple, repeatable, proven techniques or devices: you can purify, beautify, falsify, terrify, and so forth. -ification is always easy and repeatable" [20]. Landers et al. [21] view these remarks as an oversimplification within post-positivism.

Landers et al. [21] defend the positivist perspective on the impact of social constructs (variables) on gamified learning. Social constructs denote gender, age, race, income and other socioeconomic or sociocultural factors. Post-positivists view these constructs as constituent parts which may 'probably' affect the outcome of results. Because of the stance that truth is fallible, and that science cannot definitively prove cause and effect, post-positivists prefer the terms *probable causation*. Post-positivists would typically attempt to control and isolate these variables [21]. Moreover, they might conduct interviews to shed more light on a social construct. This, however, still leaves interpretivists dissatisfied; they maintain the view that social constructs such as race and gender are too dynamic and complex to be quantified or explained statistically [12].

3 Aim of the Study

Few studies have explored the sociocultural views that users, and particularly students, have of gamification [9]. We intend to address this gap by exploring the information ecology of gamification in higher education. We ground the forthcoming analysis in the primary research question: How do qualitative IS studies approach gamification implementation within an information ecology? To address this question, we undertake a systematic literature review to determine what evidence-based gamification research with qualitative methods has been conducted.

4 Theoretical Framework

We regard Hermeneutics as an appropriate 'lens' for interpreting the information ecology of gamification. Hermeneutics initially dealt with the interpretation and reinterpretation of biblical texts [22]. Gadamer [23] extended Hermeneutics to contribute to the understanding of human behaviour and social phenomena [24]. For Gadamer, the hermeneutic circle lies at the foundation of interpreting social phenomena – it involves a dialectical, interpretational relationship between the 'whole' and its 'parts'.

In Gadamer's [23] hermeneutic view, human values and meanings reside inside people who project them into the world and that varies across cultural groups [25]. For interpretive researchers, a preliminary understanding of social phenomena is positioned as the parts. The whole consists of cohesive meanings that are produced from interaction between them [24].

Klein and Myers [26] discuss how Hermeneutics can be used to interpret text analogues (e.g. organisation culture), improve systems development, and assess how technologies are adopted and how they impact society and organisations after implementation. Within the scope of this paper, an information ecology of gamification represents the whole. Our goal is to attain a more comprehensive understanding of this 'whole' by engaging in a pre-understanding of its parts.

As Nardi and O'Day [4] state, "an information ecology is a complex system of parts and relationships". Coevolution, keystone species, system, diversity and locality denote the strong dependencies and interrelationships among the different parts of an information ecology. We seek to conceptualise and develop new IS knowledge of the mentioned parts that typify gamification practices.

5 Systematic Literature Review

Systematic literature reviews are used as follows: to summarise prevailing evidence regarding a phenomenon or technology, e.g., in the context of this paper, we summarise existing empirical evidence on qualitative research on gamification practices; identify gaps in current literature in order to propose areas for future research; and to give a background in order to fittingly locate novel research activities. Systematic literature reviews, however, are also a means of supporting or contradicting theoretical assumptions. We argue for the importance of those social and cultural factors that affect the adoption of gamification [26].

5.1 Resources and Search Criteria

To increase relevance in identifying primary studies, we applied selection criteria. Kitchenham and Charters [26] describe selection criteria as a multistage process of including and excluding found studies based on certain conditions. From the onset, we limited our focus on papers published from the year 2010. This follows from Thiebes, Lins and Basten's [27] observation that 2010 is the year that gamification studies began to appear in reputable journals from related domains such as education, IS, and technology-based teaching and learning.

Furthermore, our review is limited to evidenced-based gamification studies within the boundaries of the IS discipline. According to Webster and Watson [28], primary contributions to a discipline is likely to be contained in leading journals. We started by conducting a keyword search in top-ranking IS journals. To cover a broad set of papers, we queried the search string "gamif*". We surveyed eight IS journals, which, according to the Association for Information Systems (AIS) [29], are rated as the top eight journals in IS.

These journals, listed from highest to lowest ranking, are the Management Information Systems Quarterly (MISQ), Journal of the Association for Information Systems (JAIS), Journal of Strategic Information Systems (JSIS), European Journal of Information Systems (EJIS), Information Systems Journal (ISJ), Journal of Information Technology (JIT), Journal of Management Information Systems (JMIS), and Information Systems Research (ISR). To broaden the reach and strengthen the dataset for analysis, Webster and Watson suggest that researchers also examine "conference proceedings, especially those with a reputation for quality" [28].

We decided to confine our search to conference proceedings in the AIS electronic Library (AISeL) and the Association of Computing Machinery (ACM) Digital Library. We discarded papers based on the following exclusion criteria: papers not written in English [30]; papers which are a keynote, panel discussion, book chapter, book, dissertation, work-in-progress, review, editorial, or workshop [31]; papers which do not contain the "gamif*" search string in the title, keywords or abstract [27]; papers that focus on serious or full-fledged games [27, 31]; studies of papers not conducted within a higher education context [27].

5.2 Database Searches

The journals contained little gamification research, lacking especially focus in educational settings. We therefore decided to include the Computers and Education (C&E) and Computers in Human Behavior (CHB) journals hosted in the ScienceDirect database and published by Elsevier (cf. Table 1). We subjected these papers to further exclusion criteria. Papers containing no empirical studies on gamification were not included [27]. Here, we draw on Vermeulen et al.'s [19] inference that theories and methodologies suggested so far do not align with the complexity of practical gamification phenomena – hence the incongruent findings in gamification studies conducted within positivist philosophy. Based on the inference above, we eliminated all papers which used quantitative and mixed-method data collection approaches. The exclusion criteria, hence, allowed us to select papers based on the following inclusion criteria: papers on gamification published in the identified journals and conference proceedings; studies that used purely qualitative methods to collect empirical data; studies conducted in higher education.

Table 1. Publications in selected journals and conferences from 2010 to 2019.

Journals/Conference proceedings	2010–2011	2012–2013	2014–2015	2016–2017	2018–2019	Total
MISQ	0	0	0	1	0	1
JAIS	0	0	0	0	1	1
JSIS	0	0	0	0	1	1
EJIS	0	0	0	0	0	0
ISJ	0	0	0	0	0	0
JIT	0	0	0	0	0	0
JMIS	0	0	0	1	0	1
ISR	0	0	0	0	0	0
C&E	0	1	4	6	10	21
CHB	0	1	4	23	8	36
ACM	3	40	78	60	56	237
AISeL	0	5	16	36	18	75
Total	3	47	102	127	94	373

5.3 Concept Classification Scheme

To summarise the relevant articles, we used Webster and Watson's [28] concept-centric matrix. The authors maintain that concepts organise the framework of a review. In the ambit of this study's hermeneutic underpinning, we map the parts of Nardi and

O'Day's [4] (cf. Table 2) information ecology to Webster and Watson's [28] concept-centric matrix to analyse relevant papers (cf. Table 3). We then proceeded by reading each relevant paper thoroughly and synthesising them to the concepts (parts) of an information ecology.

Table 2. The parts of an Information Ecology [4].

Parts	Description
Diversity	Reference diverse sociocultural dimensions of technology use
Locality	Users should have the agency to claim technology to be designed according to their needs
Keystone species	People who possess unique skillsets to support the proficient technology use
System and coevolution	Interrelationships among an information system's different constituents are important; via an iterative process, these constituents jointly reflect on how changes might affect the information ecology

Units of Analysis. Webster and Watson [28] suggest that reviewers isolate concepts by 'unit of analysis' because a concept might have a different meaning when considered from different levels of observation. We subcategorised each concept with subconcepts. Strong concepts evident in locality and diversity are 'design' (D), 'use' (U) and 'social or cultural engagement' (S&C). Although not explicitly stated by Nardi and O'Day's, we assign an 'iterative process' as a subcategory to the coevolution concept. 'Participatory design' is positioned as a subcategory for keystone species, signifying the inputs of various other parties other than system designers for the sustainable use.

Table 3. Concept matrix supplemented with units of analysis (adapted from [29]).

				Concepts							
				Diversity			Locality			System and coevolution	Keystone species
				Units of analysis							
Citation	Journal/Conference	Publisher	Year	D	U	S&C	D	U	S&C	Iterative process	Participatory design
[32]	SIGUCCS	ACM	2013	x	x		x	x			x
[33]	C&C	ACM	2015		x		x	x			
[34]	PerDis	ACM	2015		x			x	x		
[35]	AMCIS	AIS	2018		x		x		x		x
[36]	CHI	ACM	2018		x		x	x			
[9]	CHB	Elsevier	2018	x	x	x	x	x	x	x	x

6 Discussion

The review provides insight into empirical studies using qualitative methods to analyse gamification use in higher education in the IS field, published between January 2010 to January 2019. In general, few qualitative papers with empirical evidence have been published over the identified period. Table 3 illustrates only one paper published in 2013 while no papers were published in 2014. 2015 shows an increase of two published papers. In 2016 to 2017, no papers were published. 2018 shows an increase in publishing rate since 2015 – three papers. 2019 produced no papers.

6.1 Diversity

In this paper, we regard 'diversity' as a gamification solution to satisfy diverse learning needs by unifying multiple social viewpoints on games [9]. We reconcile this inference with Klein and Myers's hermeneutic Principle of Multiple Interpretations in IS research [24]. This principle denotes that IS research should support inquiry into multifaceted issues raised by the take-up of digital technologies [37]. The qualitative data collection techniques used in all found studies produced diverse participant perspectives. It appears that diversity in gamification research is broad and depends on a study's research purpose. The majority of the found studies focused on the use of game elements.

But because IS is a transdisciplinary field, it is apt for providing insight into a specific problem from multiple perspectives [8]. This is consistent with information ecology's emphasis on the design of a system for diverse user needs. For example, Wallis and Martinez [32] compare open source gamification platforms with commercial gamification platforms; commercial systems might provide better technical support, but an open-source platform allows practitioners to customise gamification according to the needs of their users.

In terms of usage, Wallis and Martinez [32] only seek diverse perspectives on the use of the game component, badges; Kaiser and Schmitz [34] elicit diverse views on avatars and points; Van Roy et al. [36] uncover views on points and badges. Different to these studies, Talaei-Khoei et al. [35] analyse diverse views on the game dynamic, 'competition' between teams. Aldemir et al. [9] investigate diverse perspectives of both game components as well as game dynamics.

6.2 Locality

We perceive 'locality' in the context of gamification as designers or practitioners who apply gamification in a specific context, and where social and cultural views are incorporated in different learning contexts [27]. We revert to Klein and Myers's [24] Principle of Multiple Interpretations in IS research to draw a correlation with Locality. The Principle of Multiple Interpretations denotes multiple interpretations involving multiple social agents, and in addition, an examination of the role of social context.

Surprisingly, all studies, except Aldemir et al. [9], neglected to address the social dimensions of gamification use. This is because of their choice of gamification strategies, which lack social features and exclude the social dimensions of gamification.

Understanding social views and social experience allowed Aldemir et al. [9] to appropriate game elements pertinent to learners' contexts. For example, the course structure followed the narrative (a game dynamic) based on the popular cultural phenomenon, the Harry Potter series.

6.3 Keystone Species

We identify system designers, practitioners (educators) and users (students) as essential role-players in the information ecology of educational gamification. We posit that collaboration between these 'species' is important for the implementation and use of an effective gamification system. The aforementioned postulation is based on Nardi and O'Day's [4] emphasis on participatory design of digital artefacts to improve the success of technology in a local context. We frame the concept of Keystone Species within Klein and Myers's [24] Principle of Interaction between the Researcher(s) and the Subjects in IS research. The principle holds that interpreters of technology-related phenomena interact with social actors who experience the phenomena as a means for co-interpretation and -analysis. This principle furthermore allows the interpreter to gain profound understanding of the views of social actors.

Three studies [9, 32, 35] contained elements where both instructors and students contributed to the implementation of gamification. Moreover, in these studies, open-source gamification platforms are used which give its users agency to customise game elements according to their needs. We do not foresee the direct involvement of system designers in the participatory design. Instead, we argue that their involvement in the form of technical support and the provision of customisable functions for a localised, user-centred gamification strategy is sufficient.

6.4 System and Coevolution

In the discussion of Keystone Species, we highlighted how collaboration is important for a sustainable gamification system. Once-off collaboration, however, might not be sufficient. Sustainability of an information system requires an iterative process to deal with systems that are undergoing changes. Thus, participatory design could require engaging many and even endless iterations to coevolve user needs and system changes, and vice versa [4].

Klein and Myers [24] advance the hermeneutic circle for qualitative IS research because of its iterative nature, i.e., moving back and forth between the whole and parts. We therefore suggest methodologies such as Participatory Action Research and Design Science Research, for they are iterative in nature and sound research strategies in IS [10]. Aldemir et al. [9] are the only researchers who made use of an iterative process, namely the 6D gamification design framework (cf. [38]), to refine the gamification process with all stakeholders and to deal with changes in the gamification system.

6.5 The Information Ecology of Qualitative Gamification in IS: The Whole and the Parts

We drew from the principles of Hermeneutics to determine the present role of gamification in the information ecology of institutions of higher learning. We posed the following research question: How do qualitative IS studies approach gamification implementation within an information ecology?

First, qualitative gamification in IS emphasises the importance of analysing the needs of students based on diverse sociocultural factors that affect students' learning capability. Second, qualitative IS research places prominence on an information system's ability to be highly adaptive and customisable in order to meet learning needs. Lastly, gamification solution designers should support and collaborate with instructors and students in an iterative process to sustain its ongoing use (cf. Fig. 1).

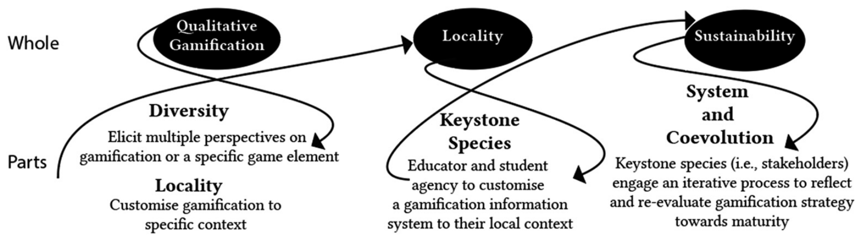

Fig. 1. Hermeneutic interpretation of a gamification information ecology (adapted from [39]).

7 Conclusion

This paper reports on a systematic review of gamification research, specifically in higher education. We illustrate the potential of qualitative IS research on gamification to meet the conditions of an information ecology. However, we recommend empirical studies of gamification that combine the parts of an information ecology in a coherent manner. More research is needed to explore the sociocultural factors that influence the adoption of gamification.

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Analysis of Students' Learning Emotions Using EEG

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Abstract. Advances in Internet technologies have enabled students to improve their learning experiences by making use of diverse sources of information and knowledge. The teaching model of the twenty-first century is gradually changing. The learning center of the student is no longer a teacher but the student himself/herself. Today, teachers are no longer the soul of teaching but the student is increasingly involved in the learning process. But students are easily affected by emotions in learning efficiency. Research has shown that learning experience can be good when students are in positive moods whereas negative emotions have the opposite effect. To improve the student's learning efficiency, teachers who are students must understand their learning emotions. When students' emotions are negative, teachers must step in to provide assistance to the students in their studies. This study analyzed brain wave signals and classified brain wave emotions by using the support vector machine (SVM) method. Brain wave emotional analysis results provide the teacher's emotions during the learning process. When students are in negative moods, teachers can intervene to assist students during learning in due course.

Keywords: EEG · Emotional analysis · Learning emotions

1 Introduction

Emotions [1] have a great influence on life and are more directly related to learning [2–4]. Focus is the fundamental of students' learning effect, and the fundamental of mindfulness is emotion. Positive emotions can provide students with a sense of achievement and satisfaction in their studies, which in turn stimulates their desire to study more. So positive emotions help to keep concentration while learning, which in turn improves the learning efficiency [5]. However, negative emotions bring anxiety, disappointment, and frustration to students in their studies. When students are constantly in a negative mood, they begin to get confused about what they are learning and may even start to get bored with the idea being presented to them. When these feelings begin to arise, the student's focus on learning begins to decline, leading to poor learning outcomes. Today's teaching strategy is a teaching model centered on student

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 498–504, 2019.
https://doi.org/10.1007/978-3-030-35343-8_53

learning. If a teacher who is a student can understand the student's learning emotions, he/she can help the student learn better in due course. Teachers are better able to play the role of "assistant".

Brain waves [6] are physiological signals in the human body. When a person is stimulated externally, nerve cells in the brain are activated and a current is released. Brain waves are a direct reflection of the state of mind and cannot be tampered with. Based on these ideas, we believe that the emotional characteristics of brain wave data should be extracted by classification algorithms, because brain wave data, human emotional and physiological conditions are related. In recent years, many studies [7–10] have explored and classified simple emotions. To analyze brain wave emotions, we used support vector machine (SVM) algorithms [11] to classify brain wave data. Finally, we use the actual emotional analysis based on the emotional state of students to determine the most appropriate teaching strategy. The experimental results obtained show that our system can really improve the learning efficiency of students.

2 Background and Related Works

2.1 Electroencephalogram

In 1875, Richard Cotton, Professor of Physiology, discovered electrical reactions from the brain on the scalps of animals. These current sensing are called brain waves. Brain neurons produce an electrical response during exercise. Studies have shown that both physical movement and emotional response or physiological state of the body are associated with electrical reactions [12–14]. That is, brain waves reflect the body's state of every minute. So brain waves can be studied for a variety of emotions. The frequency range of brain waves is 0–200 Hz. The International Federation of Societies Electroencephalography and Clinical Neurophysiology classifies brain waves into five different types which include: α wave, β wave, γ wave, δ wave, and θ wave.

2.2 Emotion

Emotions can basically be divided into positive and negative emotions. The psychologist Ekman [15] divides human emotions into four basic types which include: fear, anger, sadness, and happiness. During infancy, humans have these four basic emotions. We describe these four emotions in Table 1.

2.3 Support Vector Machine

The support vector machine is a binary linear classifier. A hyperplane is searched in space by using formula (1). This hyperplane separates two different categories as clearly as possible in space. The motivation for supporting high dimensional data in vector machines is to make it easier to classify by using the technique of kernel functions, which increase the data interval in the feature space or separating the data that was previously entangled by make data from low dimensions to high dimensions.

$$f(x) = w^T x + b \tag{1}$$

x is the input signal, which is brain wave data in our study. Brain waves are divided into δ wave, θ wave, low α wave, high α wave, low β wave, high β wave, low γ wave and medium γ wave according to frequency. Record brain waves data $x_{EEG}(t) = \{x_\delta(t), x_\theta(t), x_{l\alpha}(t), x_{h\alpha}(t), x_{l\beta}(t), x_{h\beta}(t), x_{l\gamma}(t), x_{m\gamma}(t)\}$. W is the weight vector and b is the optimal. Use these parameters to calculate the distance between the data and the hyperplane, and find the hyperplane with the largest margin to accurately classify.

Table 1. Four basic emotions.

Emotion	Description
Fear	The instinctive behavior of a creature or person in general when at risk in his/her/its lives Fear can cause physical phenomena such as a change in heart rate, elevated blood pressure, night sweats, tremors, and even symptoms of cardiac shock
Anger	Emotions are being violated, disrespectful, or mistreated, leading to instinctive self-defense of their fighting response. Emotions are angry, micro-angry, resentful, irritable, hostile, and more extreme, for hatred and violence
Sadness	Usually psychologically frustrated and failed, feeling depressed, emotions have sadness, depression, self-pity, loneliness, despair, and morbid severe depression
Joy	Emotion sits in a state of euphoria, with joy, happiness and satisfaction, and self-satisfaction, pride and excitement in the senses

3 Problem Definition

Some studies [16, 17] have used specific brain waves to classify emotions. But each brain wave reflects a different physiological response. So we had to consider all the brain waves when performing brain wave analysis. In other words, a complete analysis of brain waves must include all waves over the same time period. In this study, we considered all eight brain waves: δ, θ, low α wave, high α wave, low β wave, high β wave, low γ wave, and medium γ wave. We believe that in order to obtain more accurate emotions, all biological features in brain waves must be considered.

First, we set up a model group (VM) and a test group (VT). Each data point in the brainwave data set of the two groups is an eight-dimensional vector. Each data point in the data collection has an emotional label, $Emo_l = \{Joy, Anger, Sadness, Fear\}$. μc is the accuracy of the classification. The main goal of this study is to find the largest μc. μc can be expressed by using formula (2):

$$\mu c = \frac{TP + TN}{TP + TN + FP + FN} \tag{2}$$

where TP (True Positive) refers to the number of samples that a positive class is correctly classified. TN (True Negative) refers to the number of samples that negative classes are correctly classified. FP (False Positive), also known as type-1 error, refers to the number of samples in which negative classes are misclassified into positive classes. *FN* (False Negative), also known as type-2 error, refers to the number of samples in which positive classes are misclassified into negative classes. Thus, by maximizing *TP* and *TN*, can achieve the best μc.

4 Experimental Settings and Procedure

4.1 Experimental Settings

In this study, we chose SVM as our classification algorithm. First, we developed an emotional model of our SVM. The emotional model is built from the brainwave data of the VM. Study use NeuroSky Mind Wave Mobile Headset to collected brainwave data. We look for several 5–10 min film videos from YouTube that included different types of plots, such as comedy, tragedy or horror. We used the film as a stimulus, inviting students to watch it and we collected four types of brainwave data namely, Joy, Anger, Sadness, and Fear. We collected brainwave data of VT during student learning. Based on the established emotional model, we analyzed the brainwave data of VT by using the SVM method. Figure 1 shows how the subject wears an brain-wave instruments and collects brain waves. In Fig. 1, the subject is watching the film we prepared to stimulate the corresponding emotions, and the measured brainwaves will contain emotional data to build the emotional model.

Fig. 1. Experimental setup.

4.2 Experimental Procedure

The main purpose of this study is to help teachers provide timely assistance when students study. The study explores if students can be in a positive mood during learning and if the mood is negative, the teacher can provide help in a timely manner. The results shown in Fig. 2 demonstrate that our accuracy for emotion classified is on average higher than 80%.

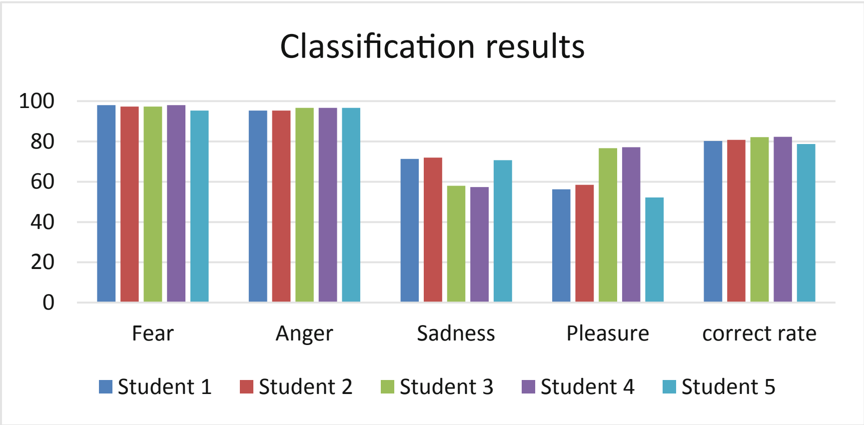

Fig. 2. Experimental results.

During the actual experiment, we asked students to wear brain-wave instruments before the class starts. We experimented with hands-on courses for the android app. Each student team must complete a project to pass this course. We selected two groups of students in the course to conduct the experiment. Each team consists of four students. One of the teams used our system in the course, and each student wore a brain-wave instrument. The other group did not. Each time for test in about 30–40 min.

The instruments work well with Bluetooth on students' phones. During the class, brain wave signals are sent to our servers for analysis. The brain wave meter transmits the brain wave signal to the phone via Bluetooth. Mobile phones send brainwave information to our system via the Internet. The student's brain wave signals are analyzed by our system. In the system, SVM classifies emotions through emotional models. Finally, the results of the analysis (as shown in Fig. 2) were returned to the students' and teacher's phone.

5 Experimental Results

During the course, the teacher is no longer a soul figure, but an auxiliary one. *How can a teacher help a student when he/she learns his/her own way?* In the experiment, our system shows each student's mood. When there is a dispute with the team, the representative needs the teacher's help. Table 2 is the advice given to the teacher, according to the emotional state of the students during the learning process, it is recommended that the teacher respond. This means that teachers will be guided by the student's learning mood, and after discussion with the students, they can provide timely intervention. In other words, if someone in the team is in trouble, the teacher will offer to help. Difficulties include disputes, sadness and so on. On the other hand, the other team does not consider the students' emotions, so teamwork is weak.

After the experiment, some key performance pointers are provided to help teachers evaluate the student's learning performance. Key performance pointers include learning

Table 2. How teachers should help students in different emotion.

Positive	Negative
When students are active, guide students to embrace more diverse ideas When students are overly concentrate, remind students to reflect on their own methods	When students are distracted, ask students to maintain a high degree of concentration When a student is angry or depressed, remind the student to relax and restore his/her mood

pleasure, attention, creativity and critical thinking, team communication, self-exploration, responsibility and project integrity. We also found that by using our system, we can help teams discuss activities more frequently, collaborate more, become more learned, and express themselves more actively. We also found that there are fewer exchanges among the peers if our proposed system does not find the cause of the problem. The reason is because teachers cannot easily understand the student's emotions in the curriculum. Thus, when students encounter some problems during the learning process, the teacher cannot modify the student's thinking in real-time.

6 Conclusion

In today's self-learning center, students promote self-study through the interaction between assistants and peers. But teachers often fail to act as a assistant in time. Our system helps teachers mentor students and guide them in a timely manner by learning emotions, focusing on thinking, and improving communication among peers. Our experiments show that using our system allows students to learn while being in a happy mood. At the end of the experiment, we found that by using our system, the efficiency of team learning and student learning is improved.

Acknowledgments. This research was partly funded by the Ministry of Science and Technology of the R.O.C. under grants MOST 106-2511-S-259-001-MY3 and 107-2221-E-259-005-MY3.

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Teaching Effectively with the Multi-screen Multimedia Integrated System

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Abstract. This system enables the learner more clearly comprehend the delivered courses through comparing or combining different contents showed simultaneously among screens. Lecturers also can utilize the multichannel stimulation to design multimedia materials on multi-screen to increase the learning effects. Likewise, the system supports functions of drawing lines, marks making, or handwriting which is similar to the traditional black board teaching. Moreover, the system adds the KINECT body control allowing more flexible adjustments like switching pages and switching the placement of counterpart screens with body movements. On the other hand, this paper also proposed an editing system for easier reproducing teaching materials based on a multi-screen system. Except for the basic marks making function, the drag and drop editing design of the editing system helps lecturers reference their lecturing contents. This multiscreen projecting system was applied in college courses and successfully proved that it does enhance the learning effectively.

Keywords: Multi-screen · Integrated teaching system · Cognitive load · Multimedia

1 Introduction

For years, the persuasive technology [1] has been applied in education and lectures on a very large scale; it is used both on computers and projecting devices. This kind of technology often explored how computing products being the role of persuasive actors. Here in this article, the persuasive technology was referred as the software products people often used in lectures to deliver concepts. These software products which can be used in conjunction with various types of multimedia (e.g. text, picture, video and animation) display systems helps deliver the educational content more clearly than traditional methods [2]. In addition, most presentation software supports the more useful features of traditional display systems, such as allowing instructors to draw lines and annotations on the screen, the same as when using a black board. Computer-aided lecturing has been shown to be more effective for both teaching and learning than simply lecturing [3]. In some real cases, however, there are still limitations. For example, when there is a need for cross citation during the delivery of specific learning content, the lecturer may need to open another program in order to access another

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 505–512, 2019.
https://doi.org/10.1007/978-3-030-35343-8_54

media form, such as a pdf documents or videos. The lecturer will also need to adjust the position of each window in order to simultaneously display the various forms of information on a single display screen. In this kind of situation the teacher will not be able to make a line that can go across the various multi-media formats. These limitations can not only cause an interruption to the flow of an instructors lecture, but also can easily cause cognitive dissonance in the minds of listeners. Nowadays, the display devices are much more mature than they were in the early days of “smart classrooms”, and we have managed to solve these limitations through the use of multi-screen displays.

2 The Current Condition and the Predicament of Persuasive Software

Microsoft PowerPoint is the most widely used persuasive software. It is easy to edit and is flexible for display. In addition to the basic typesetting, it also supports the insertion of various multimedia and hyperlinks to seamlessly connect with external or outsourced data. In education, well organized presentations which use PowerPoint have been proven to be more effective and interesting than traditional lecture methods via blackboard [3]. Other similar software applications like Keynote [4] from Apple Co., Impress [5] released by Apache OpenOffice, and even Presentation [6] from Google will equally useful with eachs useable features. These presentation software platforms all support the file type of “.ppt” and “.pttx”. “.pttx” is based on the standard language of XML and can be compressed using the ZIP format. Since the Microsoft office 2007, PowerPoint has used “pttx” as its default saved format. This research has, therefore, adopted “pttx” as the base format of this system. Although PowerPoint is extremely popular, there are limitations in its ability to exploit multiple resources simultaneously in a presentation. First, the projection mode of PowerPoint can, due to the limitations of its nature, only display one page at a time. Lecturers can only present their speech or teaching content in a linear fashion, turning to the next page only when one page has been explained. In reality, lecturers often have additional materials to reference or to compare with what is on any given page. On the other hand, both the dual coding theory and the design principle of multimedia materials that Mayer proposes support displaying similar materials simultaneously, which allows for the multi stimulation that can result from effective combinations of new information. The multiple delivery of various materials at the same time is often a better way for learners in the audience to easily grasp the logic of a complex concept that is being delivered [7–10]. The second problem which can sometimes result from using PowerPoint is the shadowing problem of referencing other resources during a presentation. Although PowerPoint allows the embedding of video or audio, the scale needs to be resized to fit into the frame, which often causes both the content and the annotated texts to become unclear. If the media is opened using another program which is better able to support high resolution display, the PowerPoint presentation mode must be interrupted, and the shadowing problem which results from running two program simultaneously will occur. Also, the control between the two programs will not be consistent; it is impossible to extend the draw and mark function of PowerPoint to the other program. Fortunately, there has been progress in what can be displayed on the monitor, and multi-display is now generally both common and relatively simple. This research will utilize a multi-screen display technique to resolve the limitations of PowerPoint.

3 Theories of Vision and Multi-screen Display Technology

Multi-screen usage was initially used to display stock market data to provide investors with the ability to observe multiple markets at the same time. Multi-screen displays are also frequently used in security monitoring system, so that every corner of a protected site can be observed simultaneously. Nowadays the Windows operating system also allows people to expand their personal computer to two or even more monitors to create a desktop which is big enough to contain large number of processes and windows [11, 12], and recently multi-screen displays have also expanded into engineering projects and even games. In education, multiscreen would be useful when the instructor or presenter wants to display a greater quantity of teaching content at the same time, enabling learners to compare, verify and map differences in various content. Although the frame distance among monitors can cause physical discontinuity in the observed screens surfaces, related research indicates that this does not affect the visual usefulness in a significant way [2, 13]. Teachers can also utilize this separation to divide the materials, and students can also organize different categories of information and absorb them to form their own unique knowledge by themselves. About the hardware technology, the AMD cooperation introduced the ATI Eyefinity system in 2010. This enables PCs to export images to up to 6 monitors using a single graphics card or parallel connecting graphics cards [14]. Also, notebooks, which are often used to project slides in educational presentation, support VGA/HDMI interfaces to extend their monitors graphics range. To this end, the multi monitor projection technique we are proposing here enables the simultaneous display of content, also a central unit to be in control while displaying these contents. The system mainly focus on the central unit control to solve and improve the limitations. The system implementation details are presented in the next section.

4 The Implementation of Proposed System

4.1 The Design of This Persuasive System

The required functions, as suggested by the analysis in Sect. 2, are listed in Table 1. The system is implemented through Microsoft Visual C# +.Net Framework 3.5, and windows 7 is suggested for the operating system.

4.2 The Editorial Sections

This base system used here is PowerPoint. Therefore, in the editorial part we hope to follow the original PowerPoint so users can easily modify it to fit a multi-screen display. In a multi-screen display, the editor needs to consider the main display and referencing pages on other screens. They can follow the pre-defined script to edit the reference plan and attach it to the comment column in PowerPoint. For example, if the main page of the PowerPoint is the one shown in Fig. 1, we would like one screen to show the website and another to show the PowerPoint introduction. We can assign monitor no.2 to show the website by typing "||2@http://www.ncku.edu.tw/" (Format: "||"concatenate the screen number and "@" concatenate with the referenced file location path or url address), and assign the DemoFile.ppt in the directory path of "D:// PPTS/ "as "||3@D://PPTS/DemoFile.ppt||".

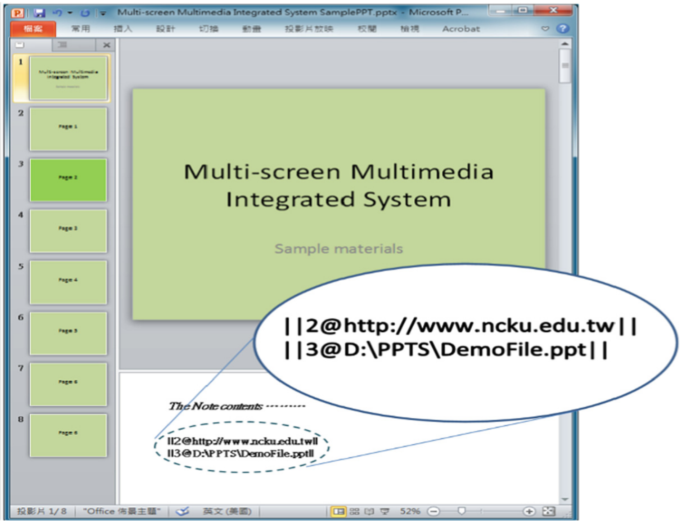

Fig. 1. Append reference script in the comment column in PowerPoint

However, this may seem complicated to many users, who may feel it takes too much time to prepare multiple pages. Therefore, we have also implemented a simple editorial system for multi-screen displays. This editorial system allows users to drag and drop the pages in the multi-screen display design process. For example, lets take one topic that requires three monitors; the user imports the PowerPoint file which already contains all the content into our editorial system and then directly drags the referenced multimedia materials into the designated position, aligning them with the main PowerPoint. In Fig. 2, the upper red frame is the main content which is set by default to the main screen and also controls the main stream of materials to be used in the delivery of the lecture. The lower blue frame is for referencing other resources on two other screens. If a video or website is to be referenced, users can click on the screen and input the file path or url. There is also a file browser option so users can easily select the needed resource. If there are multiple pages in a PowerPoint to be displayed simultaneously, users can also open the file in the lowest black frame and then drag and drop the referenced page into the designated position using the mouse. If the user wishes, after completing the edit, the file can be saved in the ".ptt" or ".fm" format.

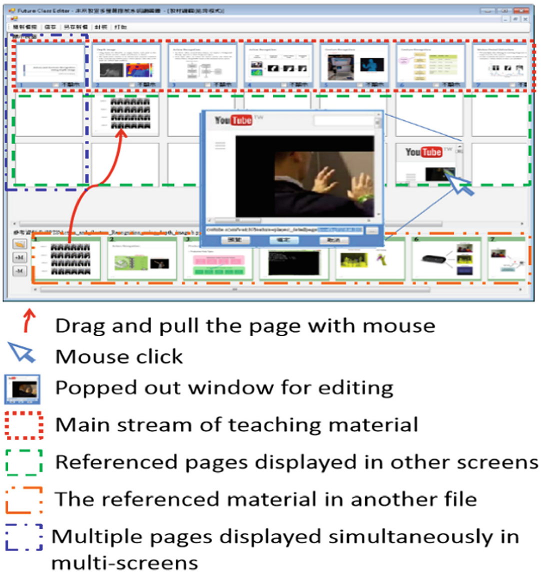

Fig. 2. The editorial page for reference (Color figure online)

4.3 The Display Sections

The most often used presentation software is PowerPoint, although additional multimedia tools are also commonly used. Therefore, the multi-screen display not only contains the control for the display sequence, but also the display object design. Table 2 shows the display program being used with various types of multimedia. Although there are several programs which can play several different multimedia files, such as the Windows media player, which supports most Multimedia formats. To display the Office Series formats it is necessary to install the Microsoft software, and most image formats can be viewed using Windows Picture Viewer. In the display system, however, we integrated these displays as well as their add-ons into the PowerPoint display. Some improvements have been made which allow both the support of multi-screen display and also the support of a unified control system.

4.4 The Multi-screen Display System

To implement the functions mentioned in Table 1, the system must control a virtual space big enough to contain all the screens used for displaying content. To accomplish this, the system first retrieves the screens locations and their resolution data. After subtracting the notebooks screen (if notebook was used), the system will construct a window with the width of summation of all screens dpi, and the height of the highest one. Then, the system will put this space in the smallest value of the x coordinator. This space will become the workspace which is used to control and display the contents across multiple screens. While actively controlling the display, the system outputs the designated content for each screen. Depending on the type of content being shown, the system will use different "display and viewer objects," as mentioned in last section, to play the content. Furthermore, there is a layer which is the same size as the workspace on top of the display layer. This layer exists as a plane on which to draw lines and mark points that will be then be displayed on top of the other materials. In addition to this function, this layer is responsible for accepting control commands such as page up/down and switching the position of screens.

Table 1.

	Required functions
The edition part	The display material can be extended from the format of existing PowerPoint materials. Therefore, the original PowerPoint format can be modified with a simple string to transform into multi-screen display supported material
The display part (in presentation mode)	The operation mode is expected to be similar to PowerPoint, requiring little change in use habits The system is able to integrate with monitors automatically The system is able to support various types of multimedias The system supports drawing functions so users can mark point across screens and different contents The system supports the display of specific pages on any selected monitor

4.5 Human Action Modeling for Control

The Motion History Image (MHI) algorithm was first proposed by Davis and Bobik [15]. There are two mainstreams of algorithms for recognizing body gestures. The first identifies the shape or pose of each image and is able to recognize movements through changes in that shape. The second algorithm recognizes the features of movements from images directly, and then interprets the motion through classifying these features. Microsoft patented the Kinect system in 2010, which tracks body movements without the subject having to manipulate any devices or controllers using its revolutionary body tracking technique. The 3D sensing technique which calculates depth by processing data that is collected through an IR source and a CMOS camera. Kinect obtains the depth data, color images, and sound through controlling the angle of the camera with a DSP processing chip and a motor for collecting the body images and filtering out background noise. After it is collected, the researcher can analyze these images. We developed a package with the algorithm of Human Action Recognition Using Weighted 3-Viewpoints Motion History Histogram added to the back end of Kinect for precisely recognizing motion. This algorithm can effectively distinguish the body in the foreground using the 3D image that the Kinect provides. It utilizes depth data which is unaffected by environmental factors to separate the body in foreground, and then analyze it using variations of Motion Energy and the Angle of 3-Dimensional Motion Orientations, thus isolating and recognizing specific body motions. Considering that the multi-screen display range is wider than a single screens range might cause students or viewers off to one side to see the data displayed less clearly than on the other side.

To overcome this potential problem, the lecturer may need to switch the contents among screens so all of the observers can see everything. That is to say, there is a need for the ability to switch pages among physical monitors in addition to the existing page up/down control. However, the standard controls on a mouse only support up and down. Adding the switching function into the mouse control is not intuitive and not convenient. Furthermore, if lecturers are able to "perform" their presentation without holding any device for control, we believe that it will be more effective for delivering information. Therefore, we have integrated the Kinect motion recognition system into our model. The lecturer can wave his or her right hand to switch the page on the right and the left hand to switch the page on the left. Waving both hands down means "go to the next page".

5 Verification and Experiments

This system was developed using the Waterfall model, with series verification and modification to complete. After the initial development, we invited ten teachers with computer teaching experience to try using this system. Most classrooms contain only one projector, therefore, we used computer monitors to simulate the conditions and we acquired the instructors feedback and made appropriate modifications. After a stable system was developed, we used a quasi-experiment to evaluate the effectiveness of a multi-screen display when delivering information or concepts to an audience. The experiment was carried out in two classes. Class A has 120 people in it and class B 119. Both classes were given the same course in computer networking. However, Class A, the experimental group, used a multi-screen display teaching environment while Class B, the control group, used the ordinary, single screen display method with reference materials opened in a variety of programs. The experiment was carried out for three weeks, and the students were given a pre-test in the first week and a post-test after three weeks to evaluate any differences in their learning.

6 Conclusions

The experimental results were analyzed with SPSS, after which a t-test was used to check if there is a differences in learning effectiveness between these two groups. To avoid skewing which may be caused by difference in the natural abilities of the students, we used the single factor analysis of covariance to evaluate the results. We used the pre-test grade as a covariance, group as single variable and post-test as dependent variable. The result is $P = 0.043 < 0.05$ which proves that the experimental group learned more than the control group. These results suggest that learning effectiveness can be improved by re-designing the system used to present teaching materials using a multi-screen display. This system allows teachers to draw across not only the screens but also mark across different multimedia materials. The delivery of concepts thus becomes clearer for listeners and reduces their cognitive load. So far, the system has only been verified in education, but we believe there are other areas where it can be effective, such as in training courses in industry or for speeches.

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Integrating the Combination of Blockchain and RPG into Undergraduate Learning

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Abstract. As an emerging technology and a factor of the era's progress, blockchain technologies have gained considerable attention in recent years. Knowledge on blockchain technologies has become important for students. Gameplay experiences foster learning as players accomplish game tasks in virtual environments. In this study, we combine the "learning by teaching" and "learning through play" to create a digital game-based learning environment for learning blockchain technologies. This study proposes and evaluates an innovative way of how the knowledge of blockchain technologies can be taught via a role-playing game (RPG), or 3D animation and comic teaching materials. To enhance the knowledge and literacy of computer science students, we designed and developed an RPG teaching material using the flipped learning and task clearance modes, which helps undergraduate students learn about and improve their cognition of blockchain technologies.

Keywords: Blockchain · Role-playing game · Flipped learning · Emerging technology · 3d animation teaching material

1 Introduction

1.1 Research Background and Motivation

Casey and Vigna [1, 2] pointed out that blockchain technology does not focus on the opportunity to get rich overnight, nor does it aim to avoid too much government control; instead, it is established to enable individuals to freely engage in financial activities. The benefits of blockchain technology is to provide a decentralized accounting method that subverts traditions, to significantly reduce the cost of trust, and then, establish an economic organizational structure in the form of a new blockchain. The applications of a blockchain include identity certification, medical care, logistics, email, visas, and loans [3]. Blockchain has far-reaching impacts on the future of students.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 513–524, 2019.
https://doi.org/10.1007/978-3-030-35343-8_55

1.2 Research Purpose

Digital educational games are innovative teaching tools, and the stimulation brought about by simulation helps students memorize more course contents [4]. The novelty of this study lies in the development of blockchain topics in role-playing games (RPG) through 3D animation teaching materials. In addition, a learning history analysis platform is constructed to link educational learning with games, and the flipped learning mode is used to apply game learning in teaching, which cultivates students' autonomous learning ability and maintains high learning enthusiasm, thus enhancing the literacy of business administration students in the field of information science in response to the rapid rise of emerging technologies. The research purposes of this study are to (1) develop digital 3D animation and comic teaching materials for blockchain knowledge and application; (2) develop the task clearance self-learning system for the blockchain game; and (3) develop teaching plans for blockchain education as the basis for blockchain courses.

2 Literature Review

2.1 Blockchain

Blockchain is driving a new wave of data exchange and transaction revolution. Its security and transparency make the transaction data credible. Through its operation model without forgery or falsification, the data can be interconnected and utilized without any concern, under multi-party authentication [5, 6]. The World Economic Forum directly named blockchain as one of the potential technologies to promote the fourth industrial revolution [7], making blockchain one of the modern emerging technologies [8].

2.2 3D Animation and Comic Teaching

In recent years, the application of 3D virtual reality in education and learning has gradually become common practice [9], as 3D virtual reality is characterized by the provision of diverse learning situations [10, 11]. In addition, realistic 3D learning materials help to improve the learning motivation and active participation of students. Therefore, the 3D animation and comic teaching materials, as well as the fun-oriented digital learning website system, are developed for classroom teaching.

2.3 RPG Task Clearance System

Crawford [12] suggested that games hold strong educational meaning, and that all games are educational activities in a sense. Therefore, computer games have the potential to be fun learning tools. As people can practice in the process of playing games, it makes their instincts more intensive, and gives them an opportunity to explore various possibilities, thus enhancing their cognition and control of self-identity and environment, while developing individual personality and intelligence [13]. Lu [14] proposed that the digital game learning mode should be used to introduce students to learning so that students are attracted to the goal-oriented problem-solving process through game-based human-computer interactions. Provided with challenging homework and feedback, students can construct knowledge in an active manner and develop their own problem-solving skills and creativity. In addition, the flipped learning mode may serve to construct new teaching modes [15]. The effectiveness of digital games can shape students' cognitive abilities and expectations for learning.

RPG refers to games in which the players play different roles, where they communicate, trade, engage in combat, decode, and explore in a virtual game scene that simulates a real-world environment [16, 17]. Liu, He, and Wu [18] suggested that when RPG is applied in teaching, students can access the virtual game scenes and play their roles. Moreover, as teachers and teaching assistants can also play their roles, leading to interaction between teachers and students in the game, teachers can gain insight into the learning effects of students in the task clearance game, promote the combination of education and fun, and stimulate the students' motivation to learn about blockchain technologies.

3 Research Method

With the progress of computers and Internet technology, students can participate in courses through various multimedia platforms such as online video and mobile devices. However, the current traditional take-home assignments are mostly specified by teachers, for students to practice. As these take-home assignments lack interactivity, most students are less willing to learn and think; instead, they just wait for their teachers to tell them what to do next. Furthermore, the traditional approach focuses on standard answers that rely on memory for learning [19]. At present, the current problems in the traditional take-home assignment method are classified into the following three points: (1) insufficient willingness to learn; (2) lack of active thinking ability; and (3) lack of effectively applying the knowledge learned to solve new problems.

RPG brings students novel experiences which enhance their learning willingness and has positive impact on learning effects. This study develops a system that combines a dynamic RPG system and static 3D animation to improve the understanding and application of undergraduates regarding blockchain, and strengthen their ability to interpret and solve problems through the integration of the task clearance application in the task scenarios. By analyzing students' learning processes, teachers can grasp their learning process, understand their common mistakes, and take targeted reinforcement measures in the teaching process to refine the teaching process. This study consists of two stages of system construction and teaching experiments. In the first stage, the course and teaching materials are designed, including course planning and design, blockchain comics, and animation production. The RPG program system development is the main goal in this stage. In the second stage, the above system is implemented in teaching including the implementation of the teaching curriculum and analysis of students' learning effects.

3.1 Research Design

Traditional classroom teaching cannot improve students' willingness to learn, as classes bore them. Blockchain is an emerging technology, and although not necessary for all disciplines, its importance and necessity for undergraduates have been clarified. Therefore, this study proposes two methods, static teaching and dynamic teaching, to reverse traditional classroom education, enhance students' willingness to learn, and improve their sense of identity to blockchain.

3.2 Research Flowchat

Figure 1 shows the flowchart of this study to produce game-based teaching materials regarding the blockchain technology.

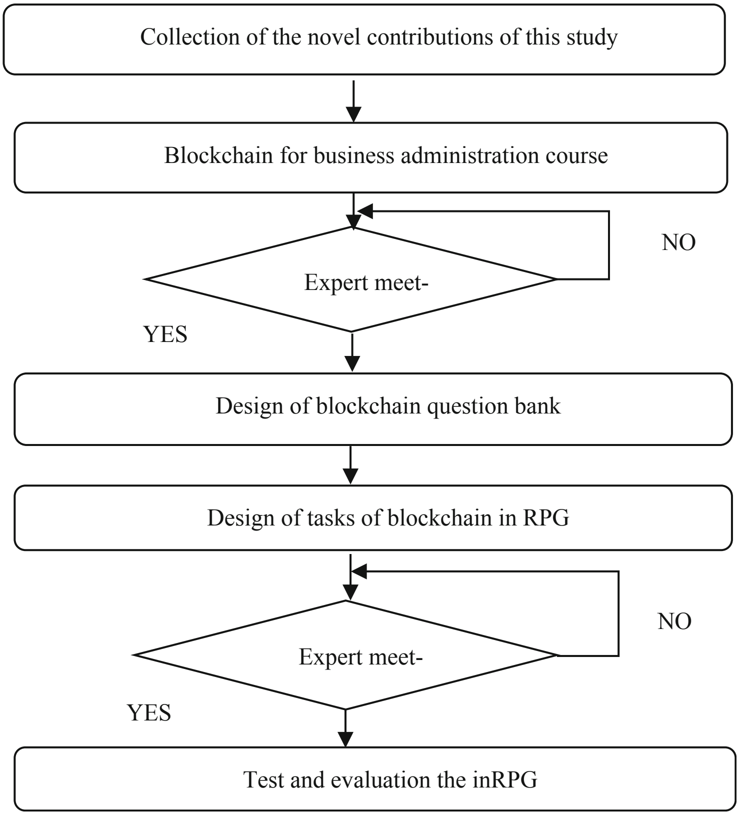

Fig. 1. Research flowchart of this study.

3.3 Teaching Material Design

The design and development of course and teaching materials are based on Animaker, which is a free online animation production website suitable for people without experience in design and which does not require any monetary costs. RPG production is based on the 11th version of RPG MAKER MV, also known as RPG production master MV, released by the Japanese company KADOKAWA in 2015.

Production of 3D animation and comic teaching materials
The use of animation in teaching can make up for the deficits of traditional teaching methods. By visualizing the abstract problem and making static pictures dynamic, this method reflects the thinking process more concretely, broadens students' horizons, stimulates their inspiration, enhances their thinking logic, and integrates the traditional teaching mode with animation and comics to achieve better teaching results. 3D animation and comic teaching materials are incorporated into teaching through digital technology, making students interested and active in learning. In addition, flipped learning can enhance their learning motivation and help form a positive attitude. Figure 2 shows the 3D characters and teaching materials of blockchain teaching animation.

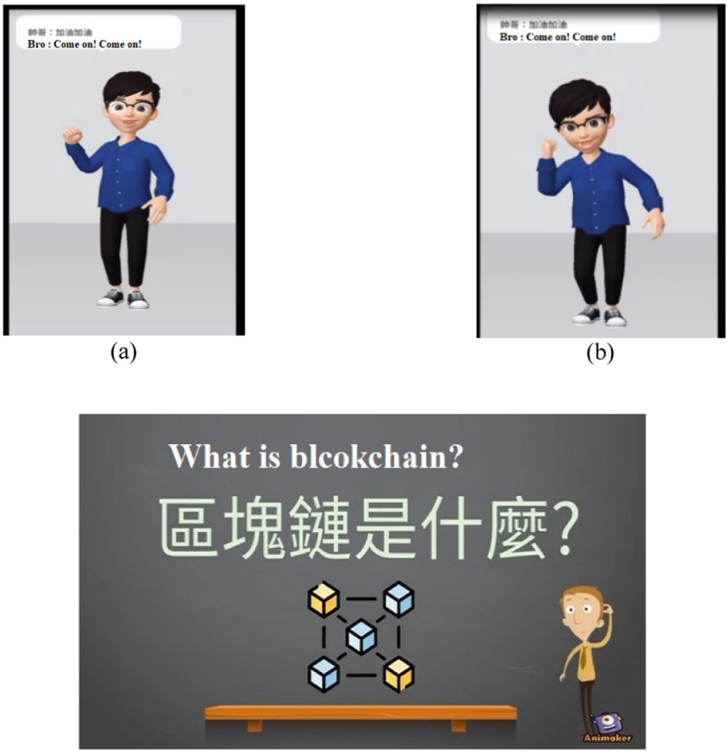

Fig. 2. The 3D characters and teaching materials of blockchain teaching animation.

RPG Production Steps

1. Start the RPG Maker MV software and add a new project.
2. After adding a new map, use the material to design the map according to the drawing mode.
3. After completing the design, switch to the plot mode, add events to specific areas, and design the plot.
4. Use the workspace at the top to add background music and adjust character content.
5. Finally arrange the game on the platform, as shown in Fig. 3.

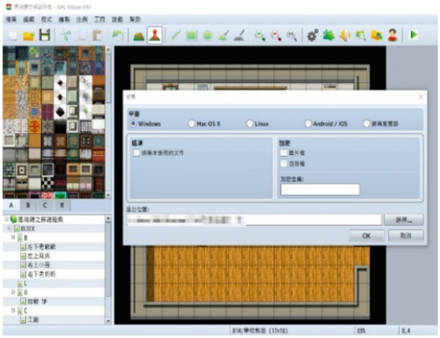

Fig. 3. RPG production page

In addition to engaging students in the task clearance game, the course can teach students to create RPG and give them the opportunity to develop their own ideas, better understand how the game works, learn more tools, enhance their competitiveness, and develop their ability to solve problems during the game production process.

Design Bottlenecks

1. Chinese fonts that displayed in game are inconsistent, as shown in Fig. 4 below.

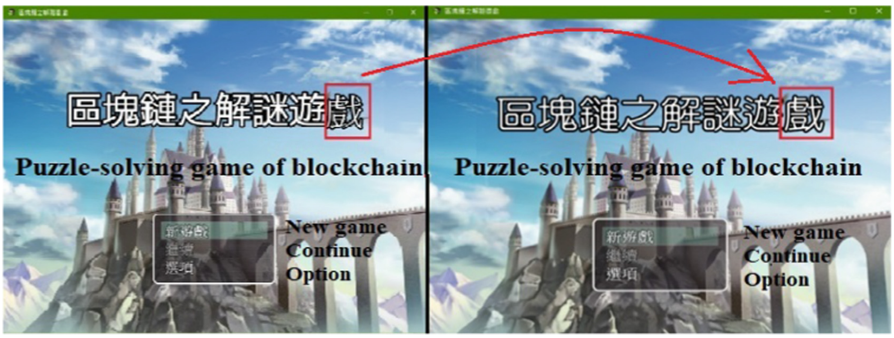

Fig. 4. Inconsistent game fonts and altered font

2. Repeated cycle of events: in the original idea, a player has only one chance to answer the question. If the player is right, he or she will receive a point; if wrong, the score will be zero. However, after answering, the player can still repeatedly enter the task and answer the question if they wish. In this case, “points” lose their meaning.

Solution

1. Regarding inconsistent game fonts, in the Save Game folder, the fonts folder contains the original font file. Users should search for other free Chinese font files from the Internet to replace the original font file, as shown on the right side of Fig. 4.
2. At the end of the first page of the event, set the self-switch A = ON, and add the plot on the second page. In the conditional area, check self-switch A, as shown in Figs. 5 and 6, respectively.

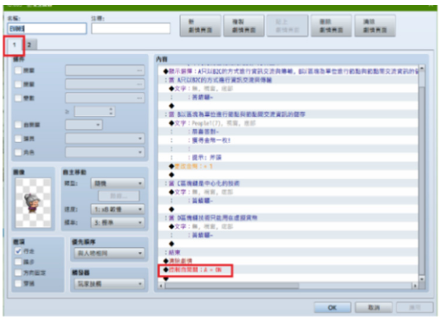

Fig. 5. Set the self-switch A = ON.

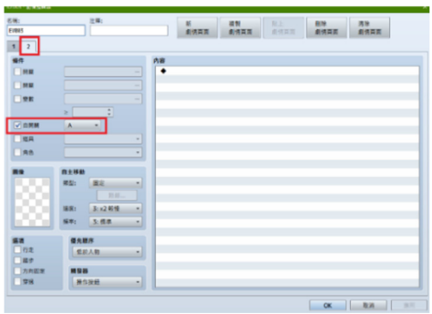

Fig. 6. Check the self-switch A.

RPG Operations

Barab et al. [20] pointed out that in an immersive game environment, by the manipulation of the virtual characters in the game and talking with other non-player characters (NPC), the learning task transfer will produce more significant learning effects than the framework of traditional descriptive or narrative textbook contents [21]. Brown, Collins, and Duguid [22] proposed the theory of situational learning which argues that knowledge only makes sense if it can produce new knowledge and be applied. Therefore, integrating blockchain knowledge into the game enables students to apply what they have learned and learn more about the emerging blockchain technologies in a new situation. The character and plot settings are shown in Table 1.

Table 1. Character and plot settings

Characters	Main characters: Shelby: The main female character of the game, a second-year college student Teacher Darren: Professor of the Information Class
Plots	Shelby, who is a university student, went to bed late one Sunday after watching a TV drama, and was late for the Information Class the next day, on Monday. The teacher of the class, Darren, threw Shelby into the world of task clearance RPG. Teacher Darren told Shelby if she cannot clear the tasks, she will have to re-take the Information Class next year. Teacher Darren hopes that Shelby can absorb the knowledge through the game and wonders whether Shelby can pass the test
Game rules	Each character of a BLOCK represents one task level which has a puzzle to be solved; therefore, there are five task levels and five puzzles. The player answers the related blockchain questions in the task levels. If the answer is correct, the player receives a prompt and a gold coin. As the player correctly answers more questions, he or she will receive more prompts and gold coins, and have a higher chance of correctly answering the next questions, indicating that the player is familiar with the concept of blockchain. Finally, the gold coins are converted into players' individual scores. There is only one condition to clear the task levels; in the five task levels, the player must clear three or more task levels to convert the gold coins into the individual score

The process of playing our designed RPG:

1. After entering the game, the player sees the classroom screen and the game instructions, as shown in Figs. 7, 8 and 9, respectively.
2. Then, the player enters the first task level, find any NPC, and start to answer questions, as shown in Fig. 10.

Fig. 7. Teacher Darren speaking in class.

Fig. 8. Shelby responding to the teacher.

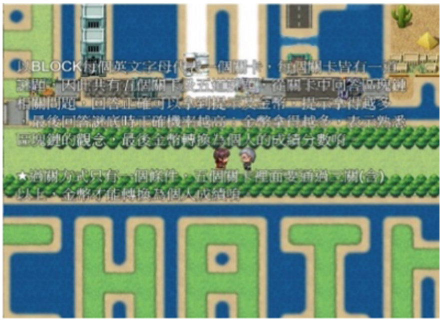

Fig. 9. Game rules.

Fig. 10. Find the NPC.

3. There are four answer options for each question (A, B, C, and D), and only one option is correct. If the correct option is selected, the player receives a gold coin. The players can press the ESC key to check the number of gold coins they have. In Fig. 11, the correct answer is option B; the player will receive the gold coin if he or she chooses option B, as shown in Fig. 12. The number of gold coins is shown on the lower left corner of the screen as shown in Fig. 13, where G stands for gold, (1G means one gold coin), and HP and MP are the abbreviations for Health Points and Magic Points, respectively. They are displayed on the upper right corner of the screen as shown in Fig. 13. In Chinese, they correspond to the value of life and strength, respectively. The game sets full HP to 450 and full MP to 90.
4. If the answer is wrong, the player does not receive a gold coin, as shown in Fig. 14.
5. After answering a question, players continue to find the next NPC to answer the next question to receive a gold coin.

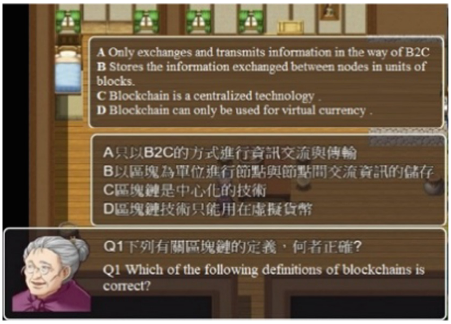

Fig. 11. Character information and equipment.

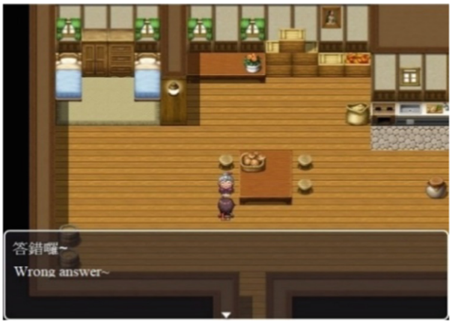

Fig. 12. Reply to wrong answer.

Fig. 13. Character information and equipment.

Fig. 14. Reply to wrong answer.

4 Expected Results

Four results are expected can obtain after the experiment are described as below.

1. Improve students' cognition and understanding of blockchain technologies.
2. Increase students' willingness to learn in this course.
3. Produce RPG using related software.
4. Create works of higher quality through mutual observation and discussion.

5 Conclusion and Suggestions

5.1 Conclusion

This study focused on the situational design of 3D animation and comic teaching materials to be provided for students and teachers, to promote fun and vividness in teaching and learning; and to simulate real life situations about knowledge of blockchain technologies. As a result, we expected that students can be more involved into the classroom teaching process to recognize the theories and applications about the blockchain, and then will enhance their learning motivation and attitudes. Thus, this study combined 3D animations and RPG to improve learning effectiveness in the hope that it can trigger a far-reaching impact on education and create professionals in blockchain technologies.

5.2 Suggestions

Suggestions for future research:

1. Explore whether the influence of the RPG task clearance system has significant effects on learning.
2. Explore whether the difference in learning effects before and after the application of the system established in this study have reached a significant level.

Acknowledgements. The authors appreciate the comments of the review committee. This study was financially supported by the Ministry of Science and Technology under grant no. MOST 108-2511-H-415-009 and MOST 108-2511-H-142 -007 -MY2.

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Mobile Learning

Design and Development of Constructivist Web-Based Learning Environment with Augmented Reality to Enhance Critical Reading for First-Year Information Technology Students of Two-Year College in Cambodia

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Abstract. The purpose of this research is to design and develop of the constructivist web-based learning environment with augmented reality to enhance critical reading for first-year information technology students of two-year college in Cambodia. The design and development research model is employed in this study [11]. The research procedure consists of four main steps: (1.) document analysis and examination of learning and teaching context, (2.) examining and analyzing the related principles and theories such as learning theory, Constructivist theories, critical reading, media theory, and technology (3.) synthesizing of the theoretical framework based on the reviewed principles and theories, (4.) synthesizing design framework for the constructivist web-based learning environment to enhance critical reading based on the theoretical framework. The participants of this study consisted of seven experts. The result of this study who that there are six basic elements of the theoretical framework includes (1) psychological base, (2) pedagogical base, (3) contextual base, (4) critical reading base, (5) media theory base, and (6) technological base. The designing framework has four mains components as following: (1.) the activation of cognitive structure and critical reading enhancement, (2.) the enhancement of cognitive equilibrium, (3.) the enhancing of knowledge construction and critical reading, and (4.) the enhancement and support of knowledge construction, and the designing frameworks has 7 elements as following: (1.) Problem base, (2.) Learning resources center, (3.) Collaboration center, (4.) Cognitive tools, (5.) Critical Reading center, (6.) Scaffolding, and (7.) Coaching center.

Keywords: Constructivist Web-based learning · Critical reading · Augmented reality · Constructivist theories

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 527–536, 2019.
https://doi.org/10.1007/978-3-030-35343-8_56

1 Introduction

With the current global trends, the world is rapidly and constantly developing effecting significantly on various filed such as economy, society, and education. The inevitably constantly changing of information, technology, and knowledge in the 21st century, a knowledge-based society, which focuses on an innovation and creativity-driven economy shapes the society and its citizens toward the future needs [1]. The knowledge-based society in the twenty-first century requires its citizens and workers to constantly learn and grow a range of the twenty-first thinking skills and competencies to navigate complex life and work environment in this globally-connected information and constantly transforming the world [2]. With the growth of technology and communication, media symbol system (web-based) characterizes hyperlink, hypertext, and hypermedia which offer links, texts, and media linked from one to others support appropriately self-seeking learning and knowledge construction. In addition to web-based, augmented reality (AR), an emerging interactive technology, found to be appropriate to integrate with the instruction and suitable to the nature of reading is abstract and boring, since reading is text-based. However, the teaching still emphasizes on teacher-centered approach and memorization. The approach does not enhance critical reading abilities, particularly. When reading abilities are poor, learning in other subjects is also poor [3]. The memorization-traditional teaching approach, which emphasizes on the application of basic procedures, will not foster learners' critical thinking or self-knowledge construction [4]. In knowledge-based economy-driven, memorization facts and simple procedures are not enough for success in the twenty-first century [1].

To address the above-mentioned issues is to design a learning environment based on instructional design theories (ID theories). The ID theories are based on the constructivist theories include cognitive constructivist [5] focusing on cognitive process and social constructivist [6] developed concept of Zone of Proximal Development, the difference between what a learner can do without help, and what they can't do. The constructivist theories which focus on knowledge construction by the learners themselves occur within the learners' cognitive process based on the prior knowledge with new information to expand cognitive structure (schema), which the teachers cannot do for learners. The teachers are only the learning facilitators and coaches to assist the environments for learning that promotes an understanding of the multiple perspectives in accordance with the real context [6]. Based on many related researches, the constructivist theory is flexible, interactive, integrating, communicative, collaborative with cross-checking, and positive to support knowledge construction within learners themselves [7–10].

Based on the aforementioned points, this paper aimed to design and develop the learning environment that enhances critical reading for first-year information technology learners in English Reading of two-year college program that the model can be used as an educational guideline for the design and development of a learning environment to assist the learners to construct knowledge, to build lifelong learning, and enhance critical reading.

2 Research Methodology

This research focuses on the design and develop of the constructivist web-based learning environment with augmented reality to enhance critical reading which consists of 3 processes: (1.) design process, (2.) development process, (3.) evaluation process.

2.1 Research Objectives

The objective of this research is to design and develop the constructivist web-based learning environment with augmented reality to enhance critical reading for first-year information technology students of two-year college in Cambodia.

2.2 Scope of Study

Sample Group
The sample group consisted of the following groups:

- The experts to review the quality of the learning environment. Three designing experts reviews the quality of the design of the learning environment, and three content experts to review the content of the learning.
- The sample group was a group of twenty-five students were randomly selected from the population of 100 for the contextual study.
- One model designer, a trainer of English subject at a vocational training in Cambodia.
- One model developer to develop the learning environment to enhance critical reading.

Scope of the Content. The content of the research is English Subject of first-year information technology of two-year college program in the second semester, the academic year 2018–2019 from Passerelles Numberiques Cambodia, a vocational training center in Cambodia.

Scope of Variables

Independent Variable
The learning management based on the constructivist web-based learning environment with augmented reality to enhance critical reading for first-year information technology learners of two-year college.

Dependent Variable
Critical reading of the learners.

– Learning achievement of the learners.
– Learners' opinions of the learners toward the learning environment.

2.3 Data Collection Process

This research is the first phase of the model research [11] which focuses on the design process and model development. The research procedures consists of four main steps:

(1.) document analysis and examination of learning and teaching context, (2.) examining and analyzing the related principles and theories such as learning theory, Constructivist theories, critical reading, media theory, and technology (3.) synthesizing of the theoretical framework based on the reviewed principles and theories, (4.) synthesizing design framework for the constructivist web-based learning environment to enhance critical reading based on the theoretical framework. The participants of this study were six experts. The data collected by document analysis and document record form.

Research Instrument

Data Collection Instrument

- The document analysis and examination form of learning and teaching context.
- A synthesis of theoretical framework record form for recording the analysis of document and related research.
- A synthesis designing framework record form for recording the analysis of document and related research for designing the learning environment.
- The experts review recording form for checking the quality of the designing framework.

Data Collection. The data were collected as follow:

- Document analysis: about the context of learning and teaching.
- Document analysis: the researcher reviewed and analyzed principles, theories, and previous related researches and studies on the web-based learning environment which consists of a variety of fundamentals include psychological base, pedagogical base, contextual base, media theory base, and technological base. Based on the synthesis of these principle, theories and previous related researches the theoretical framework for the designing framework was developed.
- Synthesizing of the theoretical framework: the framework was obtained from the analysis of related documented and related researches was used to develop the theoretical framework using the synthesis of theoretical framework record form.
- Synthesizing of the designing framework, which was developed based on the theoretical framework. The data were collected by using the recording form for the synthesis of the designing framework. After synthesis of the designing framework, the experts reviewed the quality of the designing framework based on the principle and the framework.

Data Analysis.

- Document analysis on the context of learning and teaching were analyzed using summarization, interpretation, and analytical description.
- To obtain the theoretical framework, related principle, theories, and document were analyzed and synthesized by using summarization, interpretation, and analytical description.
- The designing framework was analyzed using summarization, interpretation, and analytical description.
- The experts' assessment on the designing framework of the learning environment was analyzed by using summarization, interpretation and analytical description.

3 Findings

3.1 The Result of the Synthesis of the Theoretical Framework

The result of the synthesis of the theoretical framework: consists of six basic elements of the theoretical framework includes (1) psychological base, (2) pedagogical base, (3) contextual base, (4) critical reading base, (5) media theory base, and (6) technological base.

3.2 Context of Study

The result of this study based on the interview of the twenty-five students revealed that the current context of teaching English subject as following: the main format of teaching format is lecture-based and teacher-centered. The students were required to write down the content, the instructor might sometimes use slides presentations of the content of the lessons. Students are divides into small groups to present their report in front of the class and after that instructor might present the answers to the students. The students use a little to average the computer including various software such as Microsoft word, Microsoft excel basic, Microsoft power point and the internet. However, the students did not have experience learning the constructivist learning environment even though there were some tasks requiring simple problem-solving. In addition, students had not been provided the learning experience to specifically enhance their critical reading.

3.3 The Result of the Designing Framework of the Web-Based Constructivist Learning Environment Illustrated in Four Main Components as Follow

1. The activation of cognitive structure and critical reading enhancement: based on cognitive constructivist [5] which make the cognitive of the learner has the cognitive conflicts, and the learners have to adapt their cognitive structure or schema into equilibrium by assimilation or accommodation. Situated learning [12] is to activate the cognitive structure of the learners by presenting problems base in an authentic context. They were used to design as the component of Problem base. The critical reading [13] framework has been applied in the learning tasks for learners to enhance their critical.
2. The enhancement of cognitive equilibrium: based on the five theories that have to take into account to designing a web-based learning environment to support and enhance learners' knowledge construction and critical reading. The theories include (1.) Cognitive constructivist [5] enhancing the cognitive equilibrium of learners through two processes: (1) assimilation and (2) accommodation. (2.) Open Learning Environments (OLEs) [14] uses as static resources. (3.) SOI Theory [15] highlights three crucial cognitive processes in constructivist learning which help learners to process information better: (1) attending to relevant information (i.e., selecting), (2) mentally organizing the information into a coherent mental representation (i.e., organizing), and integrating the information with existing knowledge (i.e.,

integrating). (4.) Information Processing [16], focuses on cognition and information processing which consists of three main elements: (1) sensory register which is the first memory process to receive information in a short duration 1–3 s. If the information is interesting or in the prior knowledge of the learner, it will be recorded into the next memory step known as working memory. (2) Short term memory which holds information 7 in 15–30 s needs to go through the information process known as rehearsal or chunking. (3) long-term memory: information that passed into working memory has to be encoded into long-term memory by two methods such as encoding and elaborative process. Cognitive Load Theory [17] focuses on increasing the capacity of the working memory by chunking learning contents into 5–9 elements in 15–30 s at a time and described the information in hierarchical procedures (procedural knowledge). All of the five theories were designed as learning resources center.

3. The enhancing of cognitive structure and critical reading: To support and enhance the cognitive structure and critical reading of learning the following theories have been considered. These include Social Constructivist [6] has been designed as Collaboration center, which focuses on the social interaction between the learners and social or groups; so, they can exchange their experience and their thinking to expand their cognitive structure and their understanding. OLEs [14] has been designed as four cognitive tools include: (1) seeking Tool: tools for learner to search for information such as search engines (e.g. Google and YouTube), (2) organizing tool: allow learners to brainstorm, outline, and draw flow chart (e.g. Edraw & Mindmap), (3) collecting tool: help learner gather, transfer and manage information (e.g. Dropbox and Google Drive), and (4) communication tool: provides learners and instructor a mean to communicate, share, review work, and ask questions, (e.g. Facebook, Skype, and Email). Finally, the critical reading center has been designed to enhance the critical reading of learners based on the critical reading framework [13].
4. The enhancement and support of knowledge construction: the theories that have been adopted into the design includes Social Constructivist [6], OLEs [14] and Cognitive apprenticeship [12]. Social Constructivist [6] believe in Zone of Proximal Development (ZPD), if the learners are outside the ZPD zone means that the learner cannot perform independently because of the level of difficulty. Therefore, ZPD were used to design as scaffolding to support learners. OLEs has been designed as scaffolding center, which includes four components: (1.) conceptual scaffolding, (2.) metacognition scaffolding, (3.) procedural scaffolding (4.) strategic Scaffolding. Cognitive apprenticeship, providing the guidance needed from the expert/coach on cognitive and thinking abilities by modeling, coaching, scaffolding, articulating, and exploration to learners who cannot complete the learning tasks by themselves, situated cognition [12] has been designed as Coaching center.

The designing framework of the Constructivist Web-based Learning Environment with Augmented Reality to Enhance Critical Reading was synthesized based on above mention four main components can be illustrated as below (see Fig. 1).

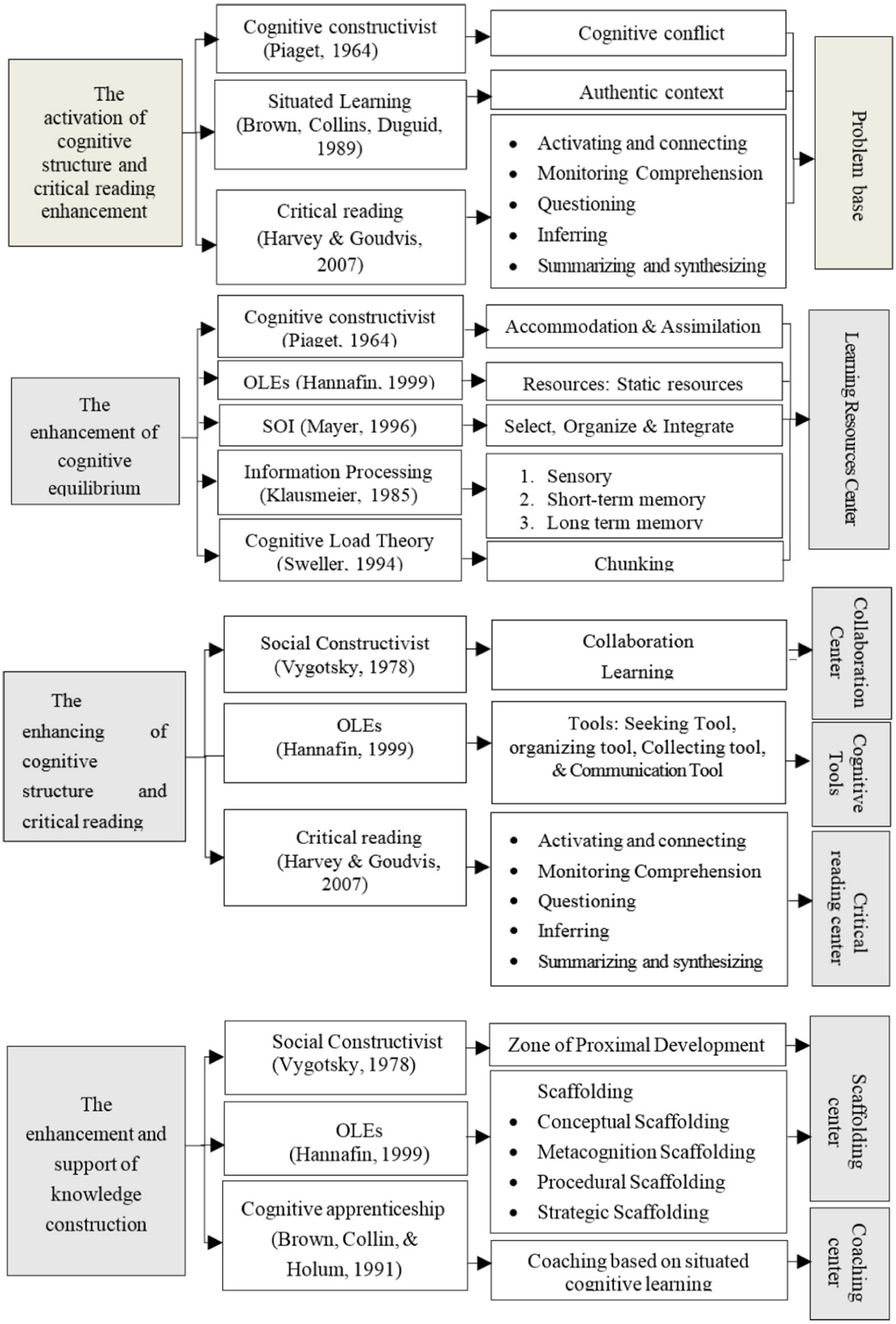

Fig. 1. Design framework of constructivist web-based learning environments with augmented reality to enhance critical reading on English Reading for first year information technology students of two-year college program in Cambodia.

3.4 The Finding of the Learning Environments

The finding of the learning environments consists of 8 components seven elements: (1.) Problem base, (2.) Learning resources center, (3.) Collaboration center, (4.) Cognitive tools, (5.) Critical Reading center, (6.) Scaffolding, and (7.) Coaching center, illustrating in (see Figs. 2 and 3).

Fig. 2. Problem base & learning resources of constructivist web-based learning environments

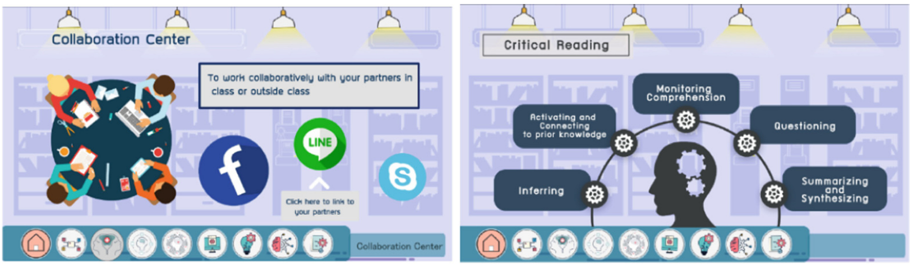

Fig. 3. Collaboration center& critical reading of the learning environment

3.5 The Constructivist Web-Based Learning Environment Efficiency Assessment

The efficiency of the constructivist web-based learning environment to enhance critical reading, illustrating as following: (1) the Experts review which was found that the learning content, media, instructional design, computer skills, constructivist learning environments, and measurement and evaluation experts, was appropriate, (2) the Learners' opinions studies were learning contents, media, and design are appropriate, and also support knowledge construction and be aware of a variety of subject specific tools and applications and able to flexibly use these in a variety of problem based and collaborative learning) which was found that there were 70% of qualified students.

4 Discussion

The result of the designing framework of the constructivist web-based learning environment with augmented reality to enhance critical reading for first-year information technology students of two-year college includes (1) psychological base, (2) pedagogical base, (3) contextual base, (4) critical reading base, (5) media theory base, and (6) technological base. The designing framework consists of four components as following: (1.) the activation of cognitive structure and critical reading enhancement, (2.) The enhancement of cognitive equilibrium, (3.) The enhancing of cognitive structure and critical reading, (4.) The enhancement and support of knowledge construction. The designing framework also includes seven elements: (1.) Problem base, (2.) Learning resources center, (3.) Collaboration center, (4.) Cognitive tools, (5.) Critical Reading center, (6.) Scaffolding, and (7.) Coaching center. This result was consistent with the studies of [7–10, 14, 19]. In addition, it was found that this designing framework of the constructivist web-based learning environment was a high-quality learning environment evident from the evaluation from various experts. Based on the experts' review, it found that the content was accurate and up to date. The design and media could enhance learners' critical reading. This resulted from the design, which based on the theoretical framework and designing framework based on the instructional design which can be applied into practices. Evidently, the knowledge construction of learners designed based on the constructivist theory. The problem base, which based on the authentic context can activate learners' cognitive process and enhance their critical reading. The designing framework also integrated the learning resources center and the critical reading center that allow learners to enhance their knowledge construction and reconstruct knowledge and critical reading. The cognitive tools enhance the cognitive of the learners. The scaffolding provides support to learners when they cannot complete the task by themselves. The elements of the designing framework enhance learners' learning to apply their knowledge to new situations. In addition, based on document analysis of Cambodia learning and teaching context, there is few studies has done to study and enhance the critical reading of learners; therefore, this designing framework of the constructivist web-based learning environment with augmented reality to enhance critical reading for first-year information technology students of two-year college, could be the initiative and guideline for English instructors who mainly use teacher-centered approach and memorization. The English instructors who lacks the analysis of the synthesis of theoretical framework and designing framework, which is essential to the designing process of the constructivist web-based learning environment to enhance critical reading efficiently. Finally, the finding of this study brightens the light to study on the learning environment to enhance critical reading in the future.

Acknowledgements. This research was supported by Ph.D. Program in Educational Technology, Faculty of Education, Research Group for Innovation and Cognitive Technology, Khon Kaen, University, and Research and Technology Transfer Affairs Division, Khon Kaen University, and Graduate School, Khon Kaen University which hereby giving the thankfulness all through this.

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Conceptualizing Factors that Influence South African Students' Intention to Choose Mobile Devices as Tools for Learning

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Abstract. South African students use mobile devices as information access and interaction tools in their daily lives but seldom use them for learning. The question is why online students minimally choose to use mobile devices for learning despite empirical case study evidence that supports m-learning. To get an answer to this question, this study investigated the factors that influence students' intention to choose to use mobile devices for learning. The study adopted the Procedure for Conceptual Framework Analysis to carry a literature analysis of selected South African m-learning case studies, ICT policies, educational ICT policies, and grey ICT reports. The result of this study is a proposed conceptual framework that categorizes factors that influence students' intention to choose to use mobile devices for learning into Country Mobile Phone Environment Factors, Educational Institution Factors, Educator Factors and Student Factors. The categories are valuable for they inform strategic planning and implementation of mobile learning services whilst ensuring the needed cooperation with students at educational institutions.

Keywords: Mobile devices · Mobile learning · Educators · Students

1 Introduction

Several case studies have demonstrated the capabilities of mobile devices as tools for learning in South Africa [1–5]. Even though the case studies confirmed mobile devices as viable tools for learning, student resistance have been reported [6]. The resistance could be against the traditional perception that mobile devices are inclusive tools that can extend e-learning in totality [7]. Due to such resistance, some researchers have advocated for a paradigm shift from an account where mobile learning services are based on e-learning to an account where mobile devices facilitate communication, generation of knowledge and sharing of information as students move and connect in learning [8]. To realize the proposed paradigm shift, it is essential that students are ready to choose to use mobile devices as information access and interaction tools in learning. Hence, this research investigates factors that influence students' intention to choose to use mobile devices for learning in South Africa. This translates to the following research question, "Which factors influence students' intention to choose to use mobile devices as tools for learning in South Africa?".

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 537–546, 2019.
https://doi.org/10.1007/978-3-030-35343-8_57

The South African context is paramount in this study, as it was observed that adoption patterns of m-learning differ from one geographic region to the other and are culturally specific [7]. The adoption patterns observed in European countries are different from those of African countries due to differences in culture, economic status, demographics and the technologies involved.

The rest of this paper is structured as follows, Sect. 2 presents the methodology, Sect. 3 presents the findings, Sect. 4 presents the proposed framework and Sect. 5 presents the conclusion.

2 Methodology

This study adopted the Procedure for Conceptual Framework Analysis [9] to analyze selected published South African case studies, polices and reports. The following stages of the procedure were followed in the analysis:

- Stage 1: The following documents pertaining to m-learning in South Africa were selected for analysis in this study: six m-learning case studies [1, 4, 10–13]; six ICT policies [14–19]; one white paper on education [20]; one green paper on post school [21]; one policy on the provision of distance learning [22]; one quality criteria guideline [23]; one good practice guide [24]; and three grey ICT reports [25–27]. The case studies were published in peer reviewed journals, books and conference proceedings between 2006 and 2018. The policies were government gazettes published between 2000 and 2014. The grey ICT reports were published by reputable research organizations such as International Telecommunication Union (ITU), Statistics South Africa and United Nations Educational, Scientific and Cultural Organization (UNESCO) between 2018 and 2019.
- Stage 2: The selected documents were extensively analyzed to have an in-depth understanding of factors that influence students' intention to choose to use mobile devices in learning. The themes that emerged were categorized according to their central foci.
- Stage 3: Two researchers independently analyzed, identified and named the codes, which they later compared.
- Stage 4: The codes from the two researchers were matched, cleaned, some dropped, others collated and then categorized.
- Stage 5: The codes from different categories were integrated to form themes and sub themes. The themes and sub themes were verified to see if each theme fits its narrative.
- Stage 6: The researchers established the relationships between the identified themes to create a conceptual framework. This is an iterative process, which included repetitive synthesis and re-synthesize until a sensible framework emerged.

3 Literature Analysis Findings

Four categories of factors that influence students' intention to choose to use mobile devices as tools for learning in South Africa emerged from the analysis. The factors are Country Mobile Phone Environment Factors, Educational Institution Factors, Educator Factors and Student Factors. The factors are presented in Table 1.

Table 1. Factors influencing students' intention to choose to use mobile devices for m-learning.

Main factor	Sub-factors	References
Country mobile phone environment factors	Broadband policy	[14–19]
	Network coverage	[25–27]
	Broadband cost	[3]
Educational institution factors	Educational policy	[21, 22, 28, 29]
	Infrastructure	[4, 30, 31]
Educator factors	Training	[5, 11, 30, 32, 33]
	Motivation	[5, 30, 33, 34]
	Workload	[5, 6, 30, 32, 35]
	Infrastructure	[4, 5, 36, 37]
Student factors	Economic status	[3–5, 30]
	Infrastructure	[3–5, 36, 38]
	Motivation	[1, 3, 5, 39, 40]

3.1 Country Mobile Phone Environment Factors

This section discusses the Mobile Phone Environment Factors of South Africa that influence students' intention to choose to use mobile devices for m-learning. The factors are broadband policy, network coverage and broadband cost.

Broadband Policy. The South African government commits to provide broadband infrastructure to its citizens through the South African National Broadband Policy of 2013 [14]. The policy supports the provision of broadband that meets the needs of its citizens. Several acts supports the implementation of the policy [14, 15, 19]. As reflected in the policies, the country pledges to provide mobile broadband that reaches all the citizens including those who reside in underserviced communities. Hence, educational institutions in South Africa have a solid foundation from which they can provide students with mobile learning services in learning.

Network Coverage. The mobile cellular network operators that provide mobile broadband are Vodacom, MTN, Cell C, Telkom mobile and Virgin mobile. The operators provide an inclusive 3G national coverage of approximately 99.5% and 4G/LTE national coverage of 85.7% [26]. This translate to a mobile phone penetration of 162.0% subscription per 100 inhabitants [25]. Statistics South Africa [27] reported that 89.5% of households are mobile primary, of which, 60.1% access internet through mobile phones [27]. Since the network coverage is 99.5%, it implies that the majority of students including those residing in rural areas have access to mobile broadband. Hence, mobile broadband coverage is available to students and they can use it for m-learning.

Broadband Cost. The South Africa National Broadband Policy of 2013 [14] commits the government to provide affordable broadband to the citizens. The policy envisioned that by the year 2020, the cost of broadband services would be 2.5% or less of the average monthly income of citizens (GNI). According to ITU [25] report, the cost of mobile broadband in South Africa in 2018 was US$8.33 per 500 Mb with a GNI of 1.82% and US$7.42 per 1 GB with a GNI of 1.64%. Since GNI broadband is lower than the recommended 2% [25], it implies that majority of the citizens, including students can afford to purchase mobile broadband. If mobile broadband is cheap, then students can choose to access learning resources through their mobile devices. Even though the cost of the broadband is affordable by international standards, some research advocate for cheaper rates for students to encourage m-learning [3].

3.2 Educational Institutions Factors

At institutional level, factors that influence students' intention to choose to use mobile devices for m-learning were found to be educational ICT policies and infrastructure.

Educational ICT Policy. The South African Department of Education (DoE) regulates the use of electronic devices through a white paper [20], a green paper [21], a policy [22], a quality criteria guideline [23] and a good practice guide [24], amongst many other policies and procedures. However, the policies and the procedures have been criticized for failing to guide the use of mobile devices in teaching and learning with respect to social networking, cyberbullying, pornography, broadband cost, and equitable access to handsets [29]. Consequently, the policies prohibit full utilization of mobile devices in learning. Vosloo [28] concluded that the policies focused on the provision of infrastructure, whose link to pedagogy was not clear. Hence, students would use mobile devices in learning if the curriculum enforces that through policy [1]. If the lecturers integrate mobile devices in teaching, then they would influence the students to use technology in m-learning.

Infrastructure. The analyzed case studies employed a number of strategies to provide software and hardware infrastructure. The strategies included utilizing social media platforms [6], SMS [2] and mobile apps [39]. The provision of infrastructure depended on the funding of a project. Funded projects provided infrastructure for mobile learning [1], whilst non-funded projects employed the Bring Your Own Device (BYOD) [6]. The funded projects provided infrastructure that included mobile devices [1, 2, 39], networking equipment, computer servers and battery charging equipment [1]. Therefore, mobile phone infrastructure for m-learning can be sourced from students through BYOD, donors or institutions.

3.3 Educator Factors

Factors that affect educators when providing students with m-learning services were found to be training, workload, and motivation. The factors directly or indirectly influence the students' intention to use mobile devices in m-learning.

Training. Traxler and Vosloo [41] argued that educator training is a fundamental factor in providing m-learning while lack of educator expertise leads to resistance. Particularly, Eicker-Nel and Matthee [34] observed lack of educator training as an obstacle hindering the provision of mobile learning in South Africa. Evidence from South African case studies [1, 5, 11] show that educators required training on how to handle mobile learning equipment, curriculum design, content design and communication. Hence, educator training is an important pillar when providing m-learning.

Workload. Analysis of the case studies revealed that educators tolerate extra workload that comes with providing m-learning if they have commitment and understand the benefits [33]. In the case studies analyzed, even though participation was voluntary, educators resisted providing m-learning if they were overloaded with work [35]. Work overload could be due to that providing m-learning require educators to go an extra mile to prepare for learning activities, content and discussions designed specifically for m-learning [33]. Therefore, the workload that come with the provision of m-learning have to be managed in order for the educators to accept it.

Educator Motivation. Educators are motivated to provide m-learning services if it is enjoyable, valuable and can associate m-learning activities with their teaching goals. Evidence from the analyzed case studies revealed that motivated educators participated in m-learning projects to improve their teaching skills or to do research [5, 6]. On the contrary, educators were demotivated by workload [35], cost for mobile access and attending training after working hours [1]. Hence, obstacles that hinder motivation of educators in providing m-learning need to be resolved in order to encourage participation.

3.4 Students Factors

The factors that influence students' intention to choose to use mobile devices in learning were identified as their economic status and motivation.

Economic Status. In South Africa, students have diverse economic backgrounds, which affect their technological infrastructure access and ownership [42]. Taking into consideration that the South African education system is indiscriminate and emphasizes equal access to opportunities [15], the financial readiness of students is a fundamental pillar for providing m-learning. Analyzed case studies revealed that some projects considered the financial aspect when they provided schools in under privileged communities with infrastructure [1, 2]. Other case studies implemented the BYOD model but it was evident that the cost of mobile phone credit (airtime) and buying a mobile device were bottlenecks [43].

Student Motivation. The analyzed case studies revealed that students would use mobile phones for learning if they can access learning resources, interact with educators and other students [44]. Hence, if m-learning apps are complex to use, students would require training on how to use them. Training motivates, enhances the skills and increase the perceived ease of use of an application. Evidence from the analyzed case studies showed that students who were trained on how to use m-learning apps were happier to participate in the projects than those who were not [5]. Students are also motivated to use their devices for m-learning by their fellow students and educators [6].

4 Proposed Conceptual Framework

The proposed conceptual framework has four main constructs that influence the students' intention to choose to use mobile devices for m-learning. The main constructs of the model are Country Mobile Phone Environment Factors, Educational Institution Factors, Educator Factors and Student Factors as illustrated in Fig. 1.

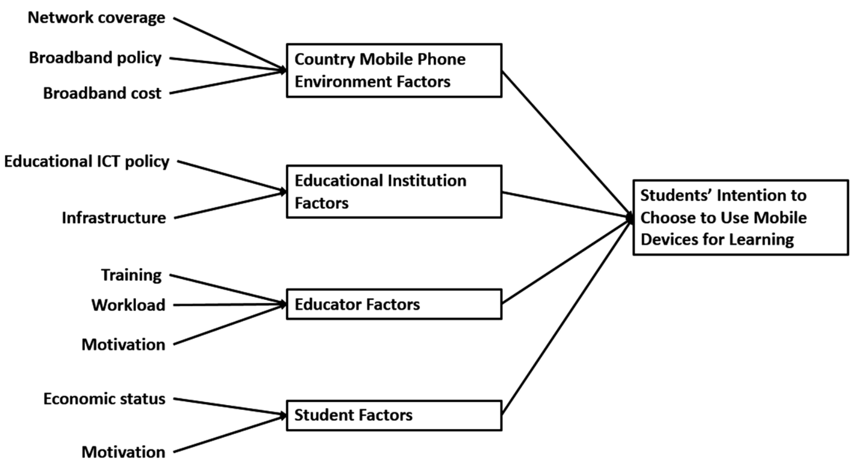

Fig. 1. Conceptual framework: factors that influence students' intention to choose to use mobile devices in m-learning.

4.1 Country Mobile Phone Environment Factors

Students would choose to use mobile devices for m-learning if their country has mobile phone network infrastructure that covers all geographical locations and has supporting policies. The policies should regulate mobile broadband and mobile device cost to be affordable to students. On the other hand, the country's Educational ICT policies should guide m-learning integration into the pedagogy, regulate risks associated with social networking, cyber bullying and inappropriate uses of mobile technologies. The Educational ICT policies have to address issues of mobile infrastructure required by educational institutions as well as students who cannot afford m-learning.

4.2 Educational Institution Factors

Students would choose to use mobile devices for m-learning if an educational institution provides m-learning infrastructure and polices. The policies guide the provision of infrastructure, services, curriculum design, teaching, lecturer and student training.

An institution can source mobile learning infrastructure in two ways. The first way is for the institution to fund all the required hardware or software for mobile learning. The second way is to make use of open source software, open resources, social media platforms and solicit devices from both students and educators through BYOD. The second approach reduces the cost but institutions should recognize through policy that there are students who are economically underprivileged and may need assistance in procuring mobile devices or broadband.

4.3 Educator Factors

Students would choose to use mobile devices for m-learning if educators are trained, motivated and have a manageable workload to allow them to provide m-learning resources.

Educators need training on how to design m-learning content, learning activities, assessment, communicating and interacting with students. Training motivates the educators because it empowers them with skills and confidence. Motivation can be enhanced through policy, by providing educators with technical support, resources, incentives and a balanced workload. The workload should allow educators to teach, research, attend symposiums and participate in university committees. If educators see the provision of m-learning as extra workload, the probability of resistance would be high.

4.4 Student Factors

Students would choose to use mobile devices for m-learning if they can economically afford it and are motivated.

The economic status of students should be considered before an institution provides m-learning so as to guard against discrimination to m-learning based on students affording to fund m-learning.

Students are motivated to use their mobile devices for m-learning if they can access tuition resources, administrative services, library resources, communicate and interact with educators. Demotivation is as a result of bad user experience, information overload and anxiety. If students see the use of mobile devices as a burden to their lives, they will not choose to use them in learning.

5 Conclusion

The study identified a number of factors that influence students' intention to choose to use mobile devices in learning and grouped them into four sets, which are the Country Mobile Phone Environment Factors, Education Institution Factors, Educator Factors and Student Factors. The factors have a cumulative effect on the students' intention to choose to use mobile devices for m-learning. However, some challenges such as broadband cost, supporting policies, lecturer motivation and workload need to be resolved to promote m-learning. The identified factors are valuable as they inform strategic planning, policy and the implementation of m-learning. Further research is needed to test the generalizability of the factors to educational institutions in developing countries.

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Chinese Key-Image Learning: An App Designed with Handwriting Evaluation and Instant Feedback to Support Chinese Character Learning

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Abstract. The purpose of this study is to develop and evaluate a mobile-assisted Chinese language learning app that introduces hundreds of fundamental Chinese characters with an innovative method, namely the Key-Image Mnemonics (KIM). This method is developed based on cognitive and learning theories (i.e., the Elaboration Theory, the Dual Coding Theory, and the Key-Word Method) and the effectiveness of this method in Chinese-as-foreign/second-language (CFL/CSL) learning is strongly supported by laboratory and classroom studies. In this paper, mobile technologies were applied to enhance the effect of this Key-Image Mnemonics. Firstly, we reviewed background research in the fields of mobile learning and character learning of CSL/CFL learners. Second, we presented the framework and development of the app, *Chinese Key-Image Learning*, which aims to support autonomous learning of CFL/CSL learners. Specifically, this app provides handwriting practices with instant feedback, including handwriting demonstration, evaluation, and error correction. Finally, we conducted a focus group to gather feedback from Chinese teachers and students to understand their perceived usefulness, perceived ease of use, and perceived enjoyment after using this app. The evaluation included both quantitative and qualitative aspects. Implications for using this app in supporting character learning of CFL/CSL learners as well as our future work are discussed.

Keywords: Chinese-as-Foreign/Second-Language (CFL/CSL) Learning · Chinese characters · Key-Image Mnemonics · Mobile learning · Technologies enhanced language learning

1 Language Learning with Mobile Technologies

1.1 The Trend of Mobile-Assisted Language Learning (MALL)

The use of mobile learning in teaching and learning has become one of the fastest-growing trends in education. Following Crompton [1], mobile learning is defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices." This mobile-assisted learning approach poses a promising

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 547–557, 2019.
https://doi.org/10.1007/978-3-030-35343-8_58

alternative to traditional learning. A meta-analysis reported a positive, better effect on learning with mobile devices than with desktop technology or without technology [2].

In mobile learning, one of the most targeted subjects is language. Using different mobile functions and apps, all four language skills (i.e., listening, speaking, reading, and writing) and culture learning can be addressed. Godwin-Jones [3] reviewed prior MALL research and put forward how the judicious use of mobile devices may have several positive outcomes for language learning. For instance, language apps leverage individual preferences on mobile devices to personal learning and develop learner autonomy; the use of images, audio, and video in language apps provide multimodal language learning tasks (for details, see [3]). In sum, apps provide a vast array of affordance for language learning.

1.2 The Design and Evaluation of MALL Apps

In the literature regarding mobile-assisted language learning (MALL), the largest volume targets vocabulary acquisition [4]. Given that the number of language apps is rapidly increasing, the growing accessibility of apps highlights the need for appropriate development and evaluation criteria.

Several researchers and practitioners have suggested useful criteria for designing and evaluating mobile apps for language learning. Heil et al. [4] examined the 50 most popular language learning apps and recommended that the development of MALL apps should incorporate more adaptive technology, contextualized language, and explanatory corrective feedback to learners. In terms of the evaluation of MALL apps, a review paper by Rosell-Aguilar [5] proposed a taxonomy of apps: (a) designed for language learning (e.g., vocabulary, grammar, listening, speaking reading, writing, and interaction), (b) not designed for but useful for language learning, and (c) dictionaries and translators. Moreover, the author presented a framework for evaluating MALL apps, which consists of four aspects (i.e., technology, user experience, pedagogy, and language learning) and corresponding criteria in a review form. An earlier version of this framework has been supported by language practitioners as they reported the framework helped them to make better-informed decisions. Combining Rosell-Aguilar's [5] current evaluation framework and the Technology Acceptance Model [6] allows us to understand users' acceptance and use of a new mobile app for language learning.

2 Key-Image Mnemonics for Supporting Character Learning

2.1 The Challenges of Learning Chinese Characters

Learning to read Chinese characters is known to be extremely daunting for beginning learners, mainly due to three characteristics of Chinese writing [7]. First, there is a lack of systematic form-sound correspondence – generally, one syllable may be shared by 11 characters with different meanings. Second, there is the sheer number of orthographic units to be memorized: tens of strokes, hundreds of chunks/radicals and thousands of frequent characters. Third, the visual complexity of orthographic units in the Chinese writing system is quantitatively eight times larger than the English writing system. These challenges hold true for first-language (L1) learners as well as second-language (L2) learners.

To address the challenges of learning Chinese characters, by employing cognitive learning theories, Chen, Chen, and Chang [8] reviewed prior research on Chinese instruction and proposed a Three-stage Character-based Instructional Framework to facilitate Chinese character learning: (a) logographic character learning with the Key-Image Mnemonics, (b) radical-deriving character learning with a grouping method and (c) complex character learning with a pithy formula method. For beginning learners, the Key-Image method plays a prominent role in supporting fundamental, basic character learning by designing images to strengthen joint attention to character form and meaning. Such design principle has been applied to 216 basic characters, and they are now available in CSL/CFL textbooks [9]. Below we review the theoretical rationale and practical implications of the Key-Image method.

2.2 The Theoretical Rationale for the Key-Image Mnemonics

The Key-Image method uses the power of the mnemonic technique, which has been widely acknowledged in language learning [10]. A mnemonic is a memory device that uses tools such as images to serve as elaborative encoding and retrieval cues, which aids the association of original information with mediators (i.e., images) that are more accessible to afford better retention of the information. In particular, the Key-Image mnemonics supports Chinese logographic character learning. These characters are single-structured and pictorial – their character forms visually resemble their referent meanings. Due to the high iconicity of these characters, visual imagery is used to associate the character's form and meaning. Figure 1 provides an example Key-Images.

Form: 己; Meaning: oneself
In Chinese culture, when people point at themselves, they usually point at their noses. So, "己," which means "oneself," looks like someone viewed from the side pointing at his/her nose.

Fig. 1. An example Key-Image for guiding joint attention to form and meaning.

Based on cognitive theories, namely the Elaboration theory [11], the Dual-coding theory [12] and the Key-Word method [13], the Key-Image method incorporates the strengths of these theories and further improves on them. In the Elaboration theory [11], the key idea is to have learners develop a meaningful context to which subsequent knowledge can be linked to achieve enhanced meaning representation, constructions, and generations. The Key-Image method implements the Elaboration theory by improving learner's memory of what is being learned through imagery-verbal elaboration. Moreover, the benefits of using imagery in the Key-Images are supported by the

Dual Coding Theory [12]. This theory postulates that human cognition consists of two subsystems, one verbal subsystem for storing abstract information such as language and one non-verbal subsystem for storing concrete information such as imagery. Given such postulation, the Key-Images support character learning better than the traditional rote memorization approach because information is coded both visually and verbally, i.e., dual coded. Furthermore, the synergy that the Key-Image forms between an imagery link and a verbal link is in line with the rationale of the Key-Word method [13]. A Key-Image is deliberately designed, for linking character form and meaning in Chinese, to be both visually similar to the form of a character (a verbal link) and highly associable with its meaning (an imagery link).

Collectively, by integrating the benefits of these cognitive theories – the Elaboration theory, the Dual-Coding theory, and the Key-Word method – the Key-Image mnemonic is expected to strengthen the form-meaning link and reduce learner memory load, making the learning process more effective and efficient.

2.3 The Empirical Implications of the Key-Image Mnemonics

The expectation of the Key-Image method's effectiveness is strongly fulfilled by laboratory and classroom studies. Previous lab studies suggest that the Key-Image method exceeds commonly-used instructional methods in supporting the beginning stage of Chinese learning. In one case [14], 25 CSL learners were instructed to construct images to represent a character on their own. The results and feedback indicated that the Key-Image method yielded better character recognition than the free association method. In another case comparing the Key-Image method with the etymology method [15], 24 CFL learners were introduced to a character based on its origin and evolution over time.

Based on the lab studies, by switching the testing environment to increase the ecological validity of the Key-Image method, classroom studies with nonequivalent pretest-posttest quasi-experiment design further extend its effectiveness in CSL pedagogy [16] as well as L1 Chinese teaching [17]. Cho et al. [16] proposed a Characters-to-Words Integration approach which assimilates Key-Images to CSL teaching with regular textbooks. They reported that CFL learners who were taught with Key-Images performed better character reproduction than those who were taught with a traditional word-based method. As for Chinese-as-first-language learners, Tsai et al. [17] examined the integration of the Key-Image method into a Chinese curriculum and its effect on improving general Chinese learning. They found that the experimental group (n = 72) performed significantly better than the comparison group (n = 71) on both a general Chinese achievement test and a Chinese learning interest questionnaire. In sum, these studies shed light on the positive impact of the Key-Image method in Chinese pedagogical settings.

Collectively, this study addressed the following research questions:

1. How to integrate the Key-Image Mnemonics into mobile-assisted language learning?
2. For such MALL application, what is users' feedback and how do the quantitative and qualitative evaluations inform us future work of the app?

3 Development of the App: *Chinese Key-Image Learning*

Chinese Key-Image Learning is a mobile-assisted language learning application, coded in Unity. This app is designed for developing reading and writing skills, specifically for Chinese characters, based on the taxonomy of mobile apps for language learning proposed by Rosell-Aguilar [5].

3.1 App Architecture

Based on Rosell-Aguilar's [5] framework for the evaluation of language learning app, the technology aspect of the *Chinese Key-Image Learning* has several features: uncluttered interface to use, clear menus to navigate, game-like features to increase engagement, and supports offline mode.

As for the pedagogy aspect (i.e., description, teaching, progress, scaffolding, feedback, use of media, differentiation, and engagement), the app handles these pedagogical features with a framework. Figure 2 presents the architecture of the pedagogical framework of *Chinese Key-Image Learning*. This app consists of four modules: Course, Knowledge, Statistics, and Settings, with pedagogical features (e.g., learning, practice, testing, and feedback) embodied in these modules. Below we provide details for the content in each module and their linkages to pedagogical features; the designs with best efforts (i.e., the Course module) are presented first.

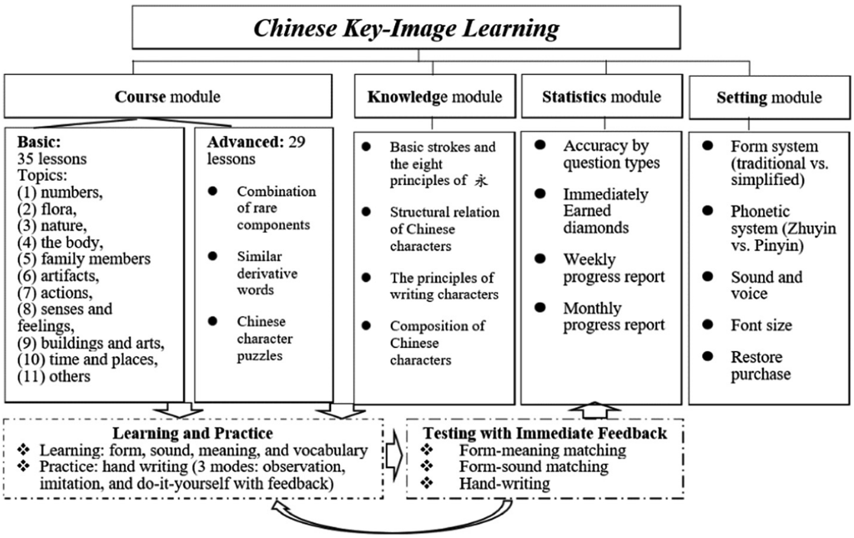


Fig. 2. A pedagogical framework of the app: *Chinese Key-Image Learning*.

3.2 Course Module

The Course module addresses differentiation with two levels: basic and advanced. Depending on learners' Chinese proficiency, they can choose lessons in different levels to meet their needs. There are 35 lessons in the basic level and 29 lessons in the advanced levels; 64 lessons in total. The difference between these two levels are mainly the complexity of characters and thus the layout for organizing these characters.

The basic level is designed to introduce fundamental characters by categorizing them into 11 topics: (1) numbers, (2) flora, (3) nature, (4) the body, (5) family members (6) artifacts, (7) actions, (8) senses and feelings, (9) buildings and arts, (10) time and places, as well as (11) others. Each topic contains approximately 10 characters.

The advanced level is designed to introduce complex characters such as visually similar characters, compound characters, and rare radicals. Therefore, three layouts for presenting these materials are developed: (1) visually similar characters are put into a larger picture with text explanation for distinguishing their visual difference easily; (2) compound characters are presented with static Key-Images with explicit composition illustration; (3) rare radicals are presented with a family tree to introduce their radical-deriving characters. Figure 3 shows four layouts for these characters with different levels of complexity and thus learning difficulty.

(a) Basic level

(b) Advanced level-visually similar characters

(c) Advanced level-compound characters

(d) Advanced level-rare radicals

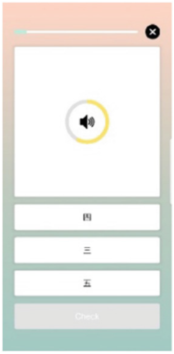
Fig. 3. Layouts for basic-level lessons and advanced-level lessons.

While there are differences between lessons in the basic and advanced levels, the teaching method and procedure are identical. For the form, sound, meaning, and usage of individual characters, multimedia is used to facilitate learning: animations to show seamless transformation from Key-Images to character forms, images to highlight visual features of characters to strengthen the link of meanings and forms, sounds to introduce pronunciations, and texts to illustrate the use for characters.

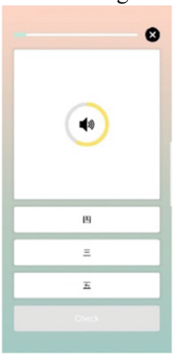
Immediate after learning, multimodal practice and testing items are given, along with instant feedback. The most sophisticated pedagogical features in the practice items are three handwriting modes designed with increasing levels of difficulty: (1) observation, (2) imitation, and (3) do-it-yourself with instant feedback. Specifically, the feedback for handwriting includes error diagnosis and guided correction. In the do-it-yourself trial, learners are provided with guided correction when they fail several times in the sequence or direction when composing strokes. The guided correction provides instant scaffolding, one of the pedagogical features of the app.

For the demonstration of giving instant feedback in handwriting practice, consult the links in Fig. 4. As for the testing items, on the left side of Fig. 4, three commonly-used testing types are employed: (1) form-meaning matching, (2) form-sound matching, and (3) handwriting. The learners may receive scores immediately after testing, earn diamonds, and track their previous attempts in the Statistics module.

(a) Form-meaning matching



(b) Form-sound matching



(c) Handwriting

Multimodal practice items with instant corrective feedback
(take handwriting for instance)
Character: 心 (meaning: heart)

(1) Observation: **https://reurl.cc/N3MGn**

(2) Imitation: **https://reurl.cc/Q0qWq**

(3) Do-it-yourself: **https://reurl.cc/7O8ky**

(d) URLs to show practice processes

Fig. 4. Multimodal testing items and handwriting practice in the Course module.

3.3 Knowledge Module

The Knowledge module offers a systematic introduction to the stroke, structure, principle, and composition of Chinese characters, each of which enables learners to establish the basic concept of Chinese characters: (1) basic strokes and the eight principles of 永, (2) structural relation of Chinese characters, (3) principles of writing characters, and (4) composition of Chinese characters. The informative content provides various materials for autonomous learning when needed.

3.4 Statistics Module

The Statistics module implements several pedagogical features; two of them are worthy of attention – progress tracking and positive reinforcement. The progress tracking includes immediately, weekly, and monthly progress reports. Learners can track their learning with charts and figures; the reports are customized to the learners' needs. Moreover, the learners can earn diamonds as positive reinforcers after they answered the questions correctly. The best feature of encouraging mastery learning may be that the learners can unlock paid lessons (after accumulating certain diamonds) by learning. Such game-like features also increase engagement.

3.5 Setting Module

The Setting module mostly takes care of the technology aspect. Depending on the learners' preferences, they can switch phonetic system (Pinyin or Zhuyin) and form system (traditional or simplified Chinese), choose font size (big, medium, or small), change the voice (male or female), and turn the sound effect on/off as appropriate.

4 Evaluation by Chinese Language Teaching Practitioners

To evaluate the design of *Chinese Key-Image Learning*, we conducted a focus group to gather feedback from users. The goals are twofold: one goal is to understand how users would accept this newly-developed app; the other goal is to collect feedback for refining this app in the future. Again, we consulted the user experience criteria in the framework proposed by Rosell-Aguilar [5] for gathering qualitative suggestions. Meanwhile, we adopted the Technology Acceptance Model [6] to collect quantitative feedback.

4.1 Research Design and Instrument

The focus group was conducted in a workshop in Taiwan with a group of 20 Chinese language teaching practitioners. After a presentation of Key-Image mnemonics and framework of this app, these practitioners were invited to try out the app freely for 30 min and give both quantitative and qualitative evaluations. We developed the instrument based on our research goals and literature review. For the questionnaire, three constructs in the Technology Acceptance Model were included; perceived usefulness (6 items), perceived ease of use (6 items), and attitude (e.g., perceived enjoyment; 6 items). All 18 items were listed in the quantitative results and were implemented with 7-point Likert-type scales, from 1 = strongly disagree to 7 = strongly agree. As for the qualitative interview, questions were developed by consulting Rosell-Aguilar's [5] criteria in user experience, including interaction, interactivity, sharing, and price.

4.2 Qualitative Feedback

For the qualitative evaluation, all participants were positive about the development and implementation of the *Chinese Key-Image Learning*. Recognitions such as "*Great app!*" "*Impressive method for character learning!*" and "*Excellent handwriting practice and instant feedback system!*" were frequently given general comments. Given that many participants are Chinese teachers who use different teaching materials, frequent pedagogical feedback is to integrate this app with commonly-used textbooks. This promising function may empower teachers to edit materials in the app on their own, for example, by selecting Key-Images of characters in certain lessons and compile them into a lesson unit. There are 70% of participants that suggested to charge this app for USD15, a price higher than its hard copy of the textbook (approximately USD10).

4.3 Quantitative Feedback

The quantitative evaluation echoed the positive qualitative feedback. Table 1 presents descriptive statistics (e.g., mean, standard deviation, range between the maximum and the minimum ratings, and skewness) of each question item. Overall, with the 7-point scale, the 18 items received means all above 6.50, suggesting that the participants agree that this app is useful, easy to use, and engaging. Such positive results were confirmed by the left-skewed distribution of individual items, which indicated that the mass of the distribution is concentrated on the right of the figure, namely stronger agreement on the item description.

5 Discussion and Future Work

This study developed and evaluated a mobile-assisted Chinese language learning app, the *Chinese Key-Image Learning*. The features of this app largely meet the criteria of each aspect of Rosell-Aguilar's [5] framework (i.e., language learning, pedagogy, technology, and user experience). First, for the language learning aspect, the use of Key-Images is grounded on cognitive and learning theories and the effectiveness of such mnemonics is supported by lab and classroom studies. Second, for the pedagogy aspect, this app incorporates explanatory corrective feedback by providing demonstration, imitation, error diagnosis, and guided correction with increasing level of difficulty and appropriate scaffolding. Further, for the technology and user experiences aspects, both qualitative and quantitative data from the app evaluation show positive feedback on this app. With all the advantages of mobile-assisted language learning, this app is promising in facilitating fundamental Chinese character learning of CFL/CSL learners.

Table 1. Summary of quantitative feedback with the Technology Acceptance Model.

Items	*M*	*S.D.*	Min	Max	Skewness
1. Using this app would enable students to gain knowledge more quickly	6.55	0.76	5	7	−1.39
2. Using this app would improve students' learning performance	6.50	0.76	5	7	−1.19
3. Using this app would increase Chinese vocabulary size of students	6.60	0.68	5	7	−1.51
4. Using this app would enhance students' character learning effectiveness	6.60	0.60	5	7	−1.25
5. Using this app would make it easier for students to learn characters	6.65	0.67	5	7	−1.78
6. I would find this app useful for students' Chinese character learning	6.60	0.60	5	7	−1.25
7. Learning to use this app would be easy for me	6.75	0.55	5	7	−2.24
8. I would find it easy to get this app to do what I want it to do	6.80	0.41	6	7	−1.62
9. My interaction with this app would be clear and understandable	6.80	0.41	6	7	−1.62
10. I would find this app to be flexible to interact with	6.55	0.76	5	7	−1.39
11. It would be easy for me to become skillful at using this app	6.75	0.64	5	7	−2.44
12. I would find this app easy to use	6.80	0.52	5	7	−2.74
13. Using this app is engaging	6.75	0.44	6	7	−1.25
14. I like to use this app	6.60	0.68	5	7	−1.51
15. I would focus on learning characters when using this app	6.50	0.76	5	7	−1.19
16. I would become interested in characters when using this app	6.55	0.69	5	7	−1.28
17. I would recommend this app to Chinese learners	6.80	0.52	5	7	−2.74
18. In general, I have high level of willingness to use this app	6.70	0.66	5	7	−2.08

Note. "This app" refers to the *Chinese Key-Image Learning*; it is shortened given word length.

As for future work, our next step is to adopt the pedagogical suggestions from the Chinese language teaching practitioners. For instance, character selection of individual lessons can be customized to different textbooks that are used in various areas. This may allow more flexibility and versatility in teachers' teaching and students' learning.

Acknowledgements. This work was financially supported by the "Chinese Language and Technology Center" of National Taiwan Normal University (NTNU) from The Featured Areas Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education (MOE) in Taiwan.

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Augmented Reality Technique Assists Target Language Learning

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Abstract. Technology assists learning and teaching covers a great deal of research and yet there are relatively few studies suggesting paths how language instructors help L2 learners cope with learning by implementing augmented reality techniques. Thus, the purpose of this study was to investigate whether the implementation of augmented reality technique helps increasing EFL learners' learning effectiveness and motivation. The research took place at a private university in the northern part of Taiwan. 216 freshmen participated in the study. Mixed method was applied in the study. The questionnaire of augmented reality technique assists learning L2 effectiveness and satisfaction were implemented at the first section of the data collection. In addition, the use of semi-structure interview and field note techniques were carried out to be the main method of gathering qualitative research data. 12 Participants were randomly selected and asked to reflect on how technology operates in the English learning context and how AR technique creates the model of interactive learning environments after participants' learning practices. The results indicated that implementing augmented reality technique was a vital strategy for producing independent thinkers and learners.

Keywords: Augmented reality · Second language learning · Independent thinker · Independent learner

1 Introduction

Generally speaking, augmented reality has provided us with valuable access toward learning. Augmented Reality (AR) is a support that reinforces to a variety of electronic devices that allow people to access data and information from wherever they are. Applying multimedia language learning opportunities for students to practice their target language allows learner-control over pace and choice of routes through the material, and provide feedback. L2 Students require a great deal of language input from school and their daily life. Currently, the traditional way of L2 knowledge delivery is provided to students through classroom lecture. However, the major challenge in obtaining L2 from the class is limited. Using augmented reality and image recognition techniques for English education develops possibilities in improving students' learning outcome and effectiveness. Previous researcher identifies five main characteristics of multimedia materials: immediacy, interactivity, control, multisensory input, and the

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 558–567, 2019.
https://doi.org/10.1007/978-3-030-35343-8_59

availability of various options for obtaining help [1]. These features allow language learners to explore, discover, ponder, search, question, answer and receive feedback [2].

Learn how technology support has created an opportunity to help industrial organizations turn massive amounts of machine-based data into actionable intelligence [3]. In other words, applying AR technique develop a new learning platform to help language learners acquire target language without time and environment limit. The success of data collection from learners' learning experiences have pushed the horizon of a new edge computing field for processing the potential to address the needs and time of learners' exposure to their target language. In this paper, the researcher introduced the use of AR toward language learning and teaching, followed by several techniques from image recognition to collaborative augmented reality to materialize the learning through daily life. Technology and data have tremendously changed the way we live, work, and s study since its inception around 2005 [4]. In addition, cloud computing, one of the edge computing as well as processing engines developed to support cloud service are also significantly influencing the way of running business, for instance, Google File System [5], MapReduce [6], Apache Hadoop [7], Apache Spark [8], and so on. Those efficient techniques motivate the researcher proposes a mobile educational framework student engagement L2 learning system. The proposed system and its implementation empower student by providing them with relevant personalized learning content anywhere anytime. In this paper, the researcher integrated image recognition technique to carry out the teaching and learning application service based on the AR technology in the L2 educational field, which are applied in the classroom for general knowledge teaching or specific skill training purpose, has a significant growing and gradually becomes the trend [9–12].

Augmented Reality (AR) has strong potential to provide both powerful contextual, on-site learning experiences and serendipitous exploration and discovery of the connected nature of information in the real world [13]. AR visual displays, a particular subset of Virtual Reality (VR) related technologies that involve the merging of real and virtual worlds somewhere along the "virtuality continuum" which connects completely real environments to completely virtual ones [14]. The concept of AR had been interpreted as having both virtual spaces on the one hand and reality on the other available within the same visual display environment [15]. AR is practiced as a media to offer learners an ideal virtual space with reality essential for target curriculum. Second language learners are expected to associate classroom theory into practice in order to reduce the gap between textbook material and daily life practices [16]. Therefore, scenario-based instruction with AR support is considered and implanted by the researcher in order to minimize the gap between the target curriculum and reality. wireless mobile devices, such as smart phones, tablet PCs, and other electronic innovations, are increasingly ushering AR into the mobile space where applications offer a great deal of promise, especially in education and training [17]. Technology offers immediate practice and provides added practice when necessary. Furthermore, technology enables target language teachers to differentiate instruction and adapt classroom activities and assignments, thus assisting L2 learners enhance the language learning experience. Technology provides an efficient platform for L2 learners to do practical language training in and after class [16]. Technology could be used for all sorts of specific language learning activities, such as oral practice, reading and writing skills development [18]. The use of technology in teaching language skills. He is of the view that media technology does offer rich and authentic online resources which incorporate attractive and multiple audio and video materials [19]. The use of multimedia authoring software that can help teachers create their own interactive language learning activities [20]. The effectiveness of Wi-Fi, Internet and hypermedia support enrich the resources for English language teaching and learning. The tremendous impact of a wide range of technology on language teaching and learning is unmeasurable, but L2 students' learning outcome with the technology support is valuable.

2 The Research Methodology

The realization of MR reality should consider the sensing method in the human-machine interaction for environment and objects. At the same time the imaging mode and equipment are also the key role for successful field application since the HM interaction is the foundation form the traditional digital E-Learning to immersive S-Learning strategy. The commonly used imaging systems include CAVE (Cave Automatic Virtual Environment), HMD (Head Mounted Display), HUD (Head Up Display), Desktop or Tabled PC, and Mobile Phone. Although the holograms can enable users to achieve a best immersive sense of environmental integration, it is not practical since the high cost and complexity for implementing the whole system. Therefore, the development and use of alternative products with similar performance and low cost is the goal of equipment manufacturers in recent years. For example, the Hololens, developed by Microsoft, is simulated by HUD as an omni-directional display [16], or 3D projective holographic display applications [17] can be the good practices. In addition, such as Magic Leap's Retina Projective Reality (Synthetic Reality, which is currently not available for sale) [18], or Oculus Rift VR, and the upcoming Oculus Gloves [19] are also claimed to has exciting effect. From the foregoing, the key issue for MR is the acquisition and identification (including location, time, and style) of users themselves and the present content, while the content, methods, timing, and interaction techniques of the information are also crucial. Therefore, the development of effective methodology to achieve the information retrieval and then combined with appropriate processing procedures to complete the integration of real-world application case requirements is the main goal of this paper.

In order to develop the prototype of MR teaching system, the design considerations of the system platform and the simulation scenarios are the most important. For system platform design, the main considerations include complexity and cost of the system construction (or duplication difficulty), experience comfort and security, integration of real and virtual contents, degree of immersive fusion, difficulty of operation interface, maintenance and adaptation of the system, and the ability for future extensive applications [20, 21]. In general, the helmet-mounted system has the advantages of simple hardware configuration and good immersive fusion degree, while the omnidirectional projection or surround field-covered CAVE design has the most natural and realistic telepresence. However, it brings the drawback of high system complexity and cost. In this paper, the helmet-mounted system design such as the Magic Leap, Hololens and Oculus of the helmet type (HUD/HMD), is adopted to achieve the good immersive perception and low construction cost. The whole system design concept is described as follows:

2.1 Design of the Display Platform

The purpose of designing this AR learning platform was to achieve the goal of high immersive experience while keeping the hardware and software cost low and efficient. In addition, language learners can easily apply the AR learning platform by installing the developed software into their smartphone, while preserving moderate immersive effect than other solutions. The Unity is adopted with the powerful ability in developing 3D scene and objects; at the meantime, it supports various AR hardware and software. Furthermore, Unity provides suitable environment for language learners to interact with and AR system and adjust digital content. In addition, Vuforia kit is implemented as the development tool to be compatible with the Unity engine and support the IOS and Android smartphone. In order to transform L2 students into independent learners, a language self-learning support system was designed and adopted to achieve students' goal. The use of AR technique creates real and virtual objects into different scenarios. The goal of this design is to improve students' target language by immersing students into daily life English learning environments. The illustrations of the AR system prototype and some operation illustrations are shown in Fig. 1.

(a) Daily life learning environment (b) Learning through a real object (c) Learning through a real object

Fig. 1. Language learning support system.

2.2 Research Data Collection

The purpose of this Mixed study was to uncover the essence of AR application toward L2 learners. Students' actual experience of the AR technology support during the course is widely regarded as providing valuable insights into language education and is a vital component of a complete instructional evaluation. 216 freshmen participated in the study. Students rated these items on a five-point Likert scale that varied from (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree).

Mixed method was applied in the study. The questionnaire of the learning satisfaction, experience, and content usefulness toward AR language learning system was implemented at the first section of the data collection. The questionnaire of learning satisfaction was being consistent with a set of positive attitudes of the person [20] regarding learning as process toward AR language learning system. In addition, the use of semi-structure interview technique was applied to be the main method of gathering qualitative research data. The data was obtained through adapted and modified open-ended questions. Participants were randomly selected and asked to reflect on how AR operated in their learning content and how AR created the model of interactive learning environments after each AR learning practice. 216 Participants were assigned to interact with the given scenario at a local supermarket. Three weeks ahead of the class.

Selection of participants was conducted via purposive sampling procedures. 216 freshmen were involved. The use of semi-structure interview technique was applied to be the main method of gathering qualitative research data. The data were obtained through adapted and modified open-ended questions. 12 randomly selected participants were asked to reflect after their AR language learning practice at the end of the semester. Individual and group interviews, classroom and informal observations were conducted for an entire semester in order to identify concerns and potential of learning effectiveness. The criteria for establishing trustworthiness are credibility, transferability and dependability. Credibility is the counterpart of internal validity [21]. Therefore, the researcher must be aware of how his/her interactions and reactions to events affect analysis of the data [22]. Observation was used by the researcher to capture the interactions and reactions to maintain self-awareness as the study proceeds [23]. Furthermore, the researcher consulted two instructors in English related programs and two instructors from the department of communication engineering to ensure all the open-ended questions covered the research scope.

3 Experimental Results and Discussions

3.1 Quantitative Data

Areas where participants' satisfaction is investigated. The first category of question on the survey dealt with the areas in which students perceived satisfaction from the AR technological learning system. Participants were evaluated on three characteristics of satisfaction toward the AR learning system. Table 1 provides the mean ratings of the results. Students were satisfied using the technological learning system was rated the highest (M = 4.04). Students were satisfied with the technological learning functions was rated as (M = 3.92). The content and the multimedia instruction were rated as (M = 3.93 and 3.88). All areas were given ratings of above 3.8, students' satisfaction is high.

Areas where participants' learning experience toward the interactive activities is investigated. The second category of question on the survey dealt with the learning experience toward the interactive activities. Participants were evaluated on three characteristics of learning experiences toward the AR interactive activities. Table 2 provides the mean ratings of students the results. Students were willing to share their learning experience of the technological learning system (M = 4.23). Students believed that the technological learning system assists teacher-learner interaction was rated as

Table 1. Students perceived satisfaction from the AR technological learning system. The Mean and Standard Deviation (from which means "strongly disagree" to which means "strongly agree").

Perceived satisfaction	*M*	*SD*
I am satisfied with using technological learning system as a learning assisted tool	4.04	0.83
I am satisfied with using the functions of the technological learning system	3.92	0.86
I am satisfied with the contents of the technological learning system	3.93	0.88
I am satisfied with technological multimedia instruction	3.88	0.86

(M = 3.74). Students believed that using the technological learning system assists learner-learner interaction was rated as (M = 3.83). All areas were given ratings of above 3.69, students' learning experiences are positive.

Table 2. Students' learning experience from the AR interactive learning activities. The Mean and Standard Deviation (from which means "strongly disagree" to which means "strongly agree").

Interactive learning activities	*M*	*SD*
I would like to share my learning experience of the technological learning system	3.69	0.90
I believe the technological learning system can assist teacher-learner interaction	3.74	0.97
I believe the technological learning system can assist learner-learner interaction	3.83	0.90

Table 3. Students perceived usefulness from the AR interactive learning activities. The Mean and Standard Deviation (from which means "strongly disagree" to which means "strongly agree").

Perceived usefulness	*M*	*SD*
I believe the contents of the technological learning system are informative	4.03	0.88
I believe technological learning system is a useful learning tool	4.10	0.89
I believe the contents of the technological learning system are useful	4.10	0.90

Areas where participants perceived usefulness from the AR interactive activities is investigated. The third category of question on the survey dealt with the perception toward the usefulness of the interactive activities. Participants were evaluated on three characteristics of learning experiences toward the AR interactive activities. Table 3 provides the mean ratings of students the results. Students believed the contents of the technological learning system are informative (M = 4.03). Students believed that the technological learning system is a useful learning tool was rated as (M = 4.1). Students believed that the contents of the technological learning system are useful was rated as

($M = 4.1$). All areas were given ratings of above 4.0, students obviously 'perceived usefulness.

3.2 Qualitative Data

Research Question 1. How are freshmen's perceptions toward AR interactive language learning system?

The integration of technology and English language learning did reduce the gap between the traditional classroom lecture and practical training. According to the researcher's previous study, it revealed that EFL learners complained and claimed that they did not have enough opportunities to apply what they had learn in class. With the AR support, students were able to be more familiar with the curriculum target and real-life material before attending the course. In addition, students had chances to practice their target language pre-class and after class.

> "I think AR technique provides me an interesting way to learning English. I like it very much because it is very useful. The most importantly, I can use it anytime and anywhere as long as Quan-Lien is open. It is a great environment to lean English. When I buy drinks or help my mom does grocery shopping, I can't believe I can learn English in this kind of practical way. I can learn not only the vocabulary but also sentences. When I press the Q button, it shows me a question which relates to the target object. If I don't know the answer, I can press the A button to find out the answer. If I did not listen clearly, I can keep press the button to repeat the question and answer" (June, male student 2)

Regarding AR facilitates English language learning, freshmen expressed that teaching should be connected to their current level of knowledge and skills. Content should be prioritized according to practical relevance.

> "I never thought that AR could be a media for me to associate with classroom material and life. technique provides interesting and active instruction. Its practical interaction enables me to internalize material from the textbook and also build up my L2 vocabulary. I think it would be wonderful to use the new technology and replace the classroom traditional teaching method (lecture)." (June, female student 3)

When designing programs for the course, technology remains potential possibilities to language teachers and learners. After experiencing AR, students preferred interactive teaching over traditional didactic lectures.

> "AR provides opportunities for me to learn the target language which related to the daily life. I can practice the target language with what I just learned. It is much better than just listen to the lecture and try to memorize new vocabulary or grammar rules." (June, female student 5)

> "I would give a positive rating for this learning system in which I always have learned a lot in a stress less environment and relax manner. My classmates and I enjoy having AR to facilitate our learning progress. Sometimes we go to Quan-Lien, we target the object, read the question, and try to find out the answer together. I learn to say new vocabulary and practice sentence example." (June, male student 6)

Research Question 2. How are the freshmen's perceptions of how AR facilitates their behavior of learning?

216 freshmen were provided with opportunities to engage in authentic practices related to their areas of study in their daily life. Students were well aware of their own responsibility for achieving their learning outcomes.

> "I used to be very quiet in the classroom. When the teacher asked me questions, I always anticipated the answers for the English practice. I was always not an active learner. After my language instructor took me to Quan-Lien to learn English. I never thought I can become an independent learner. AR technique provides me the environment to practice and apply the target language before and after the class." (June, male student 7)

A lack of motivation in learning was mentioned from two of the participants. After AR technique implement, students showed their concerns and changed their attitude in learning English.

> "In the past, I always learned English for test. Such as college entrance exam, midterm, and final. exactly is the point of learning English? I think the motivation in learning English is very important, I feel bored in class because I don't like to just sit and listen to the lecture. I think I can do self-study at home without coming to school. After my instructor took me to the local supermarket. I am learning English through AR technology support, English learning becomes alive and active." (June, male student 10)

> "Students and the instructor met at PXmart. The instructor wanted to show the students how to use a smartphone to learn their target language from the real objects. Students were asked to walk around and interact with real items. Students were encouraged to try and gain the new learning experience. During the introduction, the students were shy at first, but after few minutes they became more relaxed with AR support and learned by themselves." (Field Notes)

4 Conclusions

A functional language learning environment is to turn on every student's learning mode. The researcher observed a big change in how her students engaged themselves in the classroom activities. The key element in the academic improvement is to make student learn in the daily life. Students embraced AR with motivated participation due to a stress free learning environment. Furthermore, opportunities of learning the target language become creative and innovative. According to the researcher's previous study, it revealed that EFL learners complained and claimed that they did not have enough opportunities to apply what they had learn in class. Therefore, by using AR support, L2 students were able to practice their target language pre-class and after class. The results also indicated that implementing AR was a vital strategy for producing independent thinkers and learners. According to Chen (2018) technology offers immediate practice and provides added practice when necessary. The designed language learning support system is still at the early stage of development, it is necessary to grasp a thorough understanding of the technology in order to point out the direction of future education and research. This paper presents a new perspective on the implement and usage of language learning, characteristics, recent research work, and future research trends. In order to carry out better educational achievements, a self-learning and skill training assistance should be developed especially for language learners. Education is live, colorful, and motivated. Interactive participation, effective learning and teaching, real-life material, multi-learning techniques support should be encouraged. Effective interaction improves the language acquisition process and motivate EFL learning. Technology helps to create an active environment and promote a better verbal communication possibility.

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Needs Analyses and Initial Design of the Handheld Chinese Reading System for Classic Literature

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Abstract. In this study we aim to design and implement a handheld Chinese reading system to facilitate Chinese classic literature reading. In order to well design the system, before the system design and implementation, we used the classic Chinese literature, Dream of the Red Chamber, as the reading content for our example, to conduct the needs analysis survey on line. We wanted to investigate the target users' reading behaviors, difficulties in reading Chinese classic literature, reading experiences with the Dream of the Red Chamber, and personal preferences of the proposed system in terms of shapes and colors of the cloud images, etc. Eventually, the results of data analysis would be helpful for our system design and implementation. Thus we present a conceptual framework of the system based on the data and feedback from the participants. It is our hope with the constructive feedback from the potential users, we will be able to build a significant Chinese reading system to meet the user's actual needs and expectation so as to foster classic Chinese reading enhanced by the emerging information technologies.

Keywords: Chinese literacy · Reading system · Chinese learning

1 Introduction

Reading literacy is regarded as the foundation of learning disciplines, and important basic ability [1]. Reading is not only the connection of words, but also the need to unravel the meaning of the words, and to understand the meaning of the words after the cumulative accumulation, and then to integrate, in order to truly understand the scientific knowledge behind the words [2]. Nowadays, in addition to the paper-based books, the online resources, multimedia, and handheld devices can provide people with alternatively convenient ways of reading and thus the new technologies are changing our reading habits and bringing some challenges. For example, with the advent of the social media, such as Line and Tweet, etc., people enjoy reading short messages, short articles via the quick-scan approach on the handheld devices. It is noted that people

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 568–577, 2019.
https://doi.org/10.1007/978-3-030-35343-8_60

have difficulties in reading the classic literature that takes longer time and patience to read [3]. Chinese classic literature, for instance, carries the valuable heritage of Chinese culture. They not only can help people develop good Chinese literacy, but also can get people inspired in life and understand the value of Chinese culture. In this information era, the Internet and handheld devices have increased dramatically and become the most important media, reading habits have also turned into reading on the digital ways [4].

Thus in his study, we intend to take advantage of the attributes of the emerging technologies, such as multimedia, word cloud, etc., and develop a handheld Chinese Reading system to facilitate people's Chinese classic literature reading. The famous Chinese classic fiction, Dream of the Red Chamber, is chosen as an example for the system and content design. In order to appropriate design this system, in this paper we will firstly review the literature work from the perspective of reading literacy, Chinese learning, infographics and word cloud, secondly conduct a needs analysis and finally present our initial conceptual framework of the proposed system based on the data and feedback of the needs analyses.

2 Literature Review

2.1 Reading Literacy

Reading literacy is regarded as the foundation of learning disciplines, and important basic ability for centuries [8]. Along with the advent of information technologies, International Reading Association (IRA) [5] proposes that new literacies are rapidly generating in order to the potentials of information communication technology (ICT). Thus, traditional definitions of reading, writing, and viewing become insufficient. People should learn important issues like developing the literacy to effective information use, reading on the Internet and writing using word processing software. Therefore, reading literacy has connection with information literacy. Information literacy enables individuals to utilize the Internet and other Information and communication technologies, and identify important issues, analyze the effectiveness of information, synthesize information to answer questions, and then communicate the answers with others [6]. The connection of reading with information has been emphasized by other researchers, Chen, Hung and Yu [4] inform that as the time for young people to use the Internet has increased dramatically and become the most important media, reading habits have also turned into reading on the Internet. This change in reading style will cause a psychological shift in reading and a change in the mode of knowledge acceptance [7].

Programme for International Student Assessment (PISA), the most Influential reading literacy evaluation in the world, proposed some framework about reading literacy. It points out that reading literacy has five aspects: retrieving information, forming a broad understanding, developing on and evaluating the content of a text and reflecting on and evaluating the form of a text. The reading process is an important feature of PISA2009 reading assessment, covering three reading processes: access and retrieval, integration and interpret, and reflect and evaluation.

Since reading literacy is the basic ability that modern citizens need, how to improve the reading literacy level of Taiwanese has become a focus of government's policy [8]. It is suggested that in order to improve the ability of online reading literacy, in addition to cultivating students' positive attitude towards online reading, educators have to guide students to conduct higher-level online reading behaviors, not only to be the recipient of the message, but also be a message provider and commentator to integrate reading into life [4].

2.2 Chinese Learning with Technologies

Learning Chinese has never been a simple matter from the past to the present. Nowadays, in order to learn language well, there are some good learning ways to learn language with the development of technology. With technology supported, Chinese learning can be enhanced and a better learning effect can be achieved by technology mediated. Language requires constant practice, and it is important that students can learn anytime anywhere. So with the increase in distance learning, and expanding popularity of smartphones and tablets and widespread availability of mobile applications for language learning, it is now important to research mobile-assisted learning strategies by distance learners [9].

Language acquisition happens in natural and authentic occasions and environments. For instance, the authentic like contexts provided by the 3D virtual contexts allow Chinese as a foreign language (CFL) learners to comprehend what they heard by immersing themselves in and interacting with the environment [10]. Hence, virtual environment might be a better way to learn language in the future.

However, it must be noted that educators and researchers give students sufficient time to get acquainted with the learning system and encourage students to use it more regularly. In this case, students will be able to identify the strengths and limitations of the system and then fully utilize it for learning [11]. Moreover, how to keep the motivation up for students is also a challenge. Learning is now not limited in only a physical room, in front of a language expert, at a few hours during day time but they can access at anywhere and anytime. Interactive assignment and content give them immediate feedback; soon they change their understanding by referring to the feedback from the learning system [12].

2.3 Infographics and Word Cloud

Infographics is a visualization of data or ideas that tries to convey complex information to the audience in a manner that can be quickly consumed and easily understood [13]. With the information overflow nowadays, infographics can help readers understand the key information quickly. A good infographic will not only tell readers story, but also let reader want to know more about it. There are some major types of infographics: statistical based, timeline based, process based and location or geography based [10]. In this study we intend to help readers to facilitate their reading the complex classic Chinese literature, infographics will be applied in this study.

A word cloud is a visualization of word, text or content frequency in text file. The words in the word cloud display in different font sizes and colors. This format is useful for quickly perceiving the most prominent parts by those characteristics that are helpful for users to find important information quickly and easily. A comparative study was conducted by Lohmann et al. on several tag cloud layout methods. The results indicated that the tags' font sizes had a strong effect on search speed and more tags in the middle of the cloud attract more user attention than tags near the borders. Tags in the upper left quadrant are found more quickly [14]. The popularity of tag clouds to be explained by their ability to help users in getting a fast overview of a certain area. For different layouts, topically layouts can improve search performance for specific search tasks compared to random arrangements, and the semantic arrangement must be good enough. Otherwise, users will not be able to distinguish it from the random layouts [15]. Tag's arrangement and position of tags is important, and more users scan lists and clouds rather than read them [16].

Based on the rationale of infographics and word cloud, we will employ the suitable type of infographics, such as decent font size and colors of the word clouds, etc. for building the Chinese system. Therefore, the administration of online questionnaire for collecting the potential users' feedback becomes essential for us.

3 Needs Analysis Survey

We conducted the needs analysis survey online in order to have a better understanding on how to construct the adequate Chinese reading system to satisfy the target users' actual need. The questionnaire was designed and contained the following parts: Demographic data of the participants, user's reading habit, reading experiences of the Dream of the Red Chamber, mobile phone reading habits and image preference of the word cloud. We conducted the online survey to the potential participants who are interested in improving their classic Chinese reading enhanced with the information technology. The questionnaire was open online from February 25 to March 10, 2019, for about two weeks. Totally 127 valid online questionnaire responses were collected for data analysis. The statistical analysis software SPSS was employed for analyzing the quantitative data. The highlights of the descriptive statistic results were reported as follows.

4 Data Analysis and Results

The results presented below are analyzed based on the 127 valid questionnaires.

4.1 Demographic Data

A total of 127 questionnaire responses were collected for data analysis, including 53 (42%) males and 74 (58%) females. Their ages range from 18 to 39 years old. 108 out of the 127 (85%) participants currently are college/master/doctoral students.

4.2 Results of Reading Habit Analysis

Regarding the reading habits of the target users, 56% of the users' spend 1–5 h in a week on reading and 30% spending less than an hour in a week; and 56% spending 0.5–1 h each day.

The literary novel is the most common type of reading for the target users. Most often they read in the bedroom. Moreover, among the five reading media of paper, smart phone, computer, table computer and e-reader, the top three usually used media are paper (41%), Smart Phone (29%) and Computer (23%). Interestingly, paper still the most frequently used reading medium, mobile phone is also a popular reading medium accepted by the participants.

4.3 Reading Experiences of the Dream of the Red Chamber

This study will take the Dream of Red Chamber as an example of experiment, so this study surveyed the experience of the users reading experiences on the Dream of Red Chamber because we want to understand if there is any difficulty in reading the famous classic Chinese literature, Dream of Red Mansions. High up to 72% of the potential user did not read the Dream of Red Chamber before. In other words, only 35 people have read it, accounted for 28% of the total. Furthermore, and 24 people think that it is difficult to read the Dream of Red Chamber because there are too many characters in the Dream of Red Chamber, and it is hard to remember them would be the main difficulty in their reading experience. In addition, some other difficulties include: the text is not vernacular enough to understand what it expressed; reading consumes a lot of time in the segmented mode so that readers might forget what read before; the novel is too long.

4.4 Reading Habits with Mobile Phone

Regarding the operation system of the mobile phones, (82, 65%) participants used the Android system over the rest of the IOS (45, 35%). Moreover, overwhelmingly, high up to 120, 94% of the participants are holding the phone in a vertical way for reading, while the rest (7, 6%) using the horizontal one. However, in general, reading apps offer both vertical and horizontal ways of reading. More than 70% of people will use their mobile phones to read, and mobile reading can be divided into web browser and reading apps. Nevertheless, more people prefer app to web browser for reading.

4.5 Image Preferences

Based on the literature, word cloud and infographics can facilitate reading so that we need to investigate the user's preference for word clouds of various shapes and colors to be integrated into the readying system. Moreover, we wanted to know which kind of infographics or objects would be helpful for reading. Regarding which word cloud looks comfortable in reading? In terms of shape, the top three rankings are: 1. Circle (94, 74%); Cloud (66, 51%); and 3. Square (29, 30%) (Table 1). Even though the Square shape has bigger space and can display more prominent Chinese characters of several sizes at the glance, it takes the third place. However, the shapes of Heart and Triangle looks lovely and special, they are respectively in the fourth and fifth places.

Table 1. Shape preference

Which shape of the word cloud looks most comfortable? (Multiple Choices)		
		
Circle	Cloud	Square
94 (74.02%)	66 (51.97%)	39 (30.71%)
		
Heart	Tripod	Pentagon
34 (26.77%)	33 (25.98%)	18 (14.17%)
		
Triangle		
10 (7.87%)		

Regarding the colors, the topic three rankings are: 1. Black (78, 61%); 2. Green (60, 47%); and 3. Indigo (46, 36%) (Table 2). Black is the most popular color of their favorite. It's worth noted that none of respondents chose the Yellow color for its poorest readability resulted from the very weak color contrast.

Furthermore, regarding the type of figures to better capture the key points of the classic Chinese novel, among the Word cloud, Character relationships diagram, Event timeline, Item library, Map, HashTag, the top three in the rankings are: 1. Relationship Diagram (98, 77%); 2. Event Timeline (88, 69%); and 3. Word Cloud (36, 28%).

Table 2. Color preference.

Which color of word cloud looks most comfortable? (Multiple Choices)		
		
Black	Green	Indigo
78(61.42%)	60 (47.24%)	46 (36.22%)
		
Gray	Violet	Orange
29 (22.83%)	27 (21.26%)	22 (17.32%)
		
Blue	Red	Yellow
16 (12.60%)	3 (2.36%)	0 (0%)

Thus the relationship diagram (98, 77%) and the Event Timeline (88, 69%) are regarded as the most helpful items. The relationship diagram could solve the above-mentioned difficult situation in the Dream of Red Chamber because there are too many characters and it is difficult for readers.

After analyzing the data, the results can well inform us the user's reading behaviors and their preferences to the informatics and the word cloud. From the needs analyses, we found that most of the people did not read the Dream of Red Chamber before and they thought the Book is difficult since it's very complicate in the scenarios and the characters. In terms of helping to facilitate reading, readers indicated that the relationship, infographic and word clouds can be of top importance to get them implemented into the handheld Chinese reading system and their preferred shape of Circle, Cloud and Square; and preferred colors of Black, Green and Indigo of word clouds will be taken into account in establishing this reading system n.

5 System Design

Based on the feedback of the needs analysis, the proposed framework of the reading system will include the clouds and Infographics in this system. The system mainly will contain word and informatics sections two sections. Since the relationship diagram is regarded as the most important object to foster reading the famous but very complicated Chinese classic novel, Dream of the Red Chamber.

5.1 Word Clouds Section

The web word cloud generator will be used to create each chapter's word cloud. Before reading, the users can click the "Cloud" icon get an overview of the key characters, places and events in the book chapter. The prominent Chinese characters display on the screen can give the readers hints or clues of the key ideas in each chapter. In other words, readers can have the highlights and attention of the content of each chapter upon seeing these word clouds. Moreover, the readers could rate the word clouds in return to help the system referentially provide the better clouds to the others. In addition, meanwhile, the character's image cloud in corresponding to the word cloud will appear to support and facilitate the reading (Fig. 1).

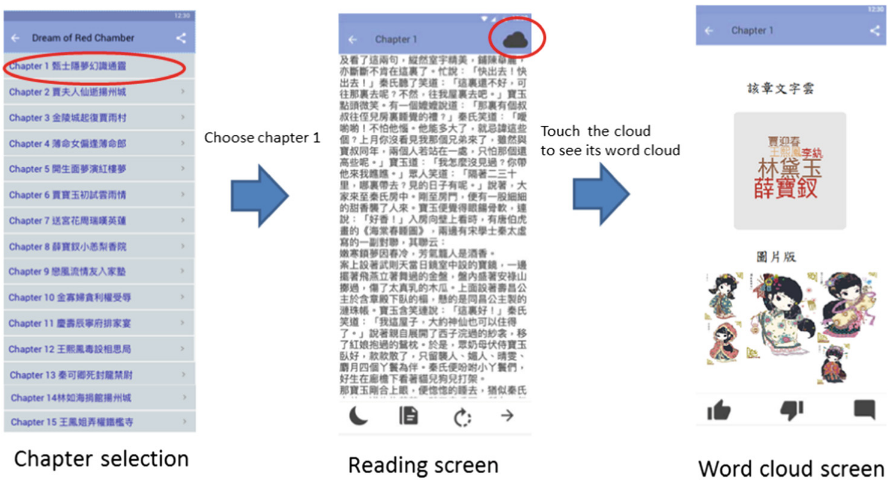

Fig. 1. Schematic diagram

5.2 Infographics Section

The system will provide readers with a tool to generate various types of relevant charts. Through the process of constructing a diagram, readers can organize what they have read. The output will be a relational chart, a time series chart or a map. The diagrams can demonstrate their understanding of the content of each chapter. Moreover, they can use the charts to solve the problems of fragmented reading and quickly relocate and recall the contents of the book by means of the infographic they produced. Furthermore, the readers can share their infographic with the other readers and also see the other people's final products, to make sure whether or not his or her understanding is right by comparison of the infographic presentations.

6 Conclusion and Future Work

Nowadays, reading classic literature becomes a challenge to people. However, how we can take advantage of the emerging technologies to facilitate reading comprehension and efficiency is the aim of this study. Through the data collection and needs analysis, the results of the target users' feedback give us a useful guideline in developing the system. Since the famous classic literature is long and complicate, it consumes us a lot of time and efforts after we try to lunch this system design. By trying to integrate the word cloud and informatics into the Dream of the Red Chamber is challenging but significant. The results of the needs analysis timely give us feedback to strengthen the original concept on constructing the handheld reading system. The system implementation is still undergoing.

We hope the system will be implemented in the next semester and the in-field experiment to the target users will be carried out soon. It is our hope that we will be able to collect the empirical data and do data analysis. We will be glad to share with the conference participants the result of the study at the time of the conference. Consequently we hope the system can meet the target user's expectation and satisfy their desire in reading the great literature work in the future.

Acknowledgments. The authors would like to thank the research grant support partially from the Ministry of Science and Technology (MOST), R.O.C., under the grant No. MOST 105-2511-S-007-002-MY3.

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New Perspectives in Education

Employing Blockchain Technology in Instructional Design and Learning Content Creation

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Abstract. Blockchain technology, a secure ledger of transactions distributed among a network of computers is the technology that enables value transaction on the Internet, which has the potential to create new foundations for our economic and social systems. Blockchain technology has widely been used in the finance and e-commerce industries for processing payments and smart contracts. Consensus algorithms, which are used to achieve agreement on data among distributed systems, are mostly determine by the type of blockchain, i.e. public, private, or federated, and are used for the verification and validation of transactions in such blockchain platforms. Current application of blockchain technology in the educational sector has mostly been for keeping student records, storing and validating diploma and degree certificate for academic credentials. Most of the available consensus algorithms for blockchain provide some form of reward to miners e.g. in the form of cryptocurrency. For blockchain to be adapted and used for other educational applications such as the creation of learning contents, the right consensus algorithm is needed. Since a Learning Content Creation will have little or no reward for participants and also not need "mining", the consensus model selection will need to treat participants fairly so to not push them away. In this introductory paper, we briefly review the available consensus algorithms and provide our insight how the Blockchain framework can be adapted for instructional design and learning content creation. A proposed framework which will lead to further studies and the development of such system is discussed here.

Keywords: Blockchain · Learning content creation · Instructional design

1 Introduction

Blockchain technology is a shared, secure ledger of transactions distributed among a network of computers, and is a transparent and verifiable system that will change the way people exchange value and assets, enforce contracts and share data [1]. Blockchain technology also known as Distributed Ledger Technology, in general, can be described as a way to manage data. Unlike relational databases which centralize the management

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 581–588, 2019.
https://doi.org/10.1007/978-3-030-35343-8_61

of data by entrusting this activity to a trusted authority, Blockchain decentralizes it by allowing a group of individuals anonymous to each other, to manage data without them having to trust themselves [2]. It allows participants to secure transactions and transfer assets at a low cost [3].

Blockchain is the technology having the potential to create new foundations for our economic and social systems. It has the potential to become the system of record for all transactions [4]. Though originally linked to Bitcoin and the underlying technology for other cryptocurrency applications, it has a broader use than only in cryptocurrency and the financial application. The idea of public ledger and a decentralized environment can be applied to various applications in other industries [5].

This paper introduces the concept of a Blockchain based Learning Management System (LMS), particularly for learning content creation and Evaluation. Such a system will increase learners' participation and improve the speed to make changes to learning contents as needed so learners can gain the right knowledge from the learning content.

2 Blockchain in Education

Most applications using blockchain technology and its framework are in the finance and commerce industries. However, there have been studies focused on how blockchain technology can be applied in education. Presently, most of blockchain application to education have been to support academic degree and certificate management and evaluation of learning outcomes [3]. The certificate data would be added to the blockchain by the awarding institution which the student can access, share with employers, or link from an online CV, providing a persistent public record secured against changes to the issuing institution or loss of its private records. Though blockchain provides an evidence of an award with a student's identity, it is not able to verify trustworthiness of either party [6].

In addition to being used to create, manage, and verify the validity of digital certificates, blockchain technologies have the ability to create data management structures giving users control and ownership of their data. This, as mentioned in Grech and Camilleri's report, can significantly reduce educational organizations' data management costs, as well as liability resulting from data management issues [7]. Blockchain technology can help protect teachers' intellectual property from being taken by others, thus improving the security of intellectual property [3].

3 Consensus Algorithms

Consensus is a dynamic way reaching a collaborative agreement within a group. All participants of the group should play an active role in the process as the agreement reached could benefit the group as a whole [8]. Consensus protocols and algorithms, the engine of a blockchain, are determined by the type of blockchain the platform expects to cater to, and how the algorithms ability to produce intended results can be determined. The following are some of the determinants

- Security: if all nodes offer same valid output as following set rules.
- Real-time Value: if all the right nodes participating a consensus produces a value.
- Fault Tolerance: if it can recover from failure of a participating node [9–11].

Blockchain can be categorized into three groups namely,

- Public Blockchain – a permissionless distributed ledger open to anyone's participation,
- Federated Blockchain – a distributed ledger that operates under the leadership of a group and doesn't allow just anyone to participate in the validation and verification process, and
- Private Blockchain – where participating members are known and trusted by the network [12].

3.1 Proof of Work (PoW)

PoW, the first consensus protocol used for Bitcoin blockchain also called mining, is based on a costly CPU computation for hashing (SHA-256) and verifying blocks on the network. The average amount of work required is exponential in the number of zero bits required in the hash and the difficulty of work determined by a moving average number of blocks per hour [13]. The first node to solve the cryptographic puzzle in finding the winning hash gets to add its proposed block to the blockchain after the puzzle is verified and accepted by peers on the network and claims the mining reward [9, 10]. Proof of Work consensus algorithm works well in an open, permissionless public ledger environment where any node can participate and start mining.

3.2 Proof of Stake (PoS)

PoS uses a random system to choose the creator of the next block. This is in part dictated by the economic stake (how much cryptocurrency) a user holds and how long the user has held that stake [14]. This list of initial users or nodes is tracked by the Casper contract and can evolve based on new nodes joining [9].

Delegated Proof of Stake and Leased Proof of Stake are some variants of PoS. In Delegated Proof of Stake, stake holders vote or appoint delegates to validate and create blocks instead of doing so themselves [15]. Leased Proof of Stake (LPoS) on the other hand encourages nodes with low stakes to lease out stakes to vote for a node which is then allowed to create the new block if it turns out to be the node having more stakes. Upon winning, the staking node collects transaction fees and also shares the fees proportionally with its leasing nodes [16].

3.3 Proof of Elapsed Time (PoET)

PoET also operates under a lottery type system. Every validator picks a random wait time from a trusted function which relies on Intel Software Guard Extension (SGX) enabled CPUs. The validator with the shortest wait time who in turn finish waiting becomes leader for the new block [17, 18].

3.4 Byzantine Fault Tolerance (BFT)

BFT derived from the Byzantine Generals' Problem, is the ability of a distributed network to function correctly despite malicious attacks from its peers. Practical Byzantine Fault Tolerance (pBFT) algorithm, a variant of BFT proposed by [19] uses the concept of a replicated state machine with voting taking place among the replicas. Replica's send their decisions to the leader node. There are four phases in each round of a pBFT consensus, also called views. A request is sent to the leader node, who in turn, broadcasts it to the replica nodes who executes the request and send their reply. The final result is an agreement from all the honest nodes. Leader nodes are changed in a round robin type, though a majority of honest nodes can also remove a leader node if they find it to be faulty [20].

3.5 Sieve

SIEVE consensus algorithm supplements pBFT by adding speculative execution and verification phases to handle non-deterministic requests in the chain and also allow consensus to be run on the output state of validators which are usually deterministic. If diverging values are detected in any number of replicas, the values are sieved out. If several processes are found to have diverging values, the offending operation itself can be sieved out [9, 21].

In the comparison and summary of consensus models, [9] groups some of these models based on cost of participation, scalability, trust model, and transaction rate as well as the type of blockchain. In the summary, PoW is found to be more suitable for permissionless distributed ledgers while BFT and its variants more suitable for permissioned ledgers. PoS and PoET can be used with both permissioned and permissionless ledgers.

4 Learning Content Creation and Instructional Design Based on Blockchain

Instructional design is a technology that incorporates known and verified learning strategies into developing learning experiences and environments. These learning environments promote the acquisition of efficient and effective knowledge and skills appealing to students and directing them to appropriate learning activities, while guiding, monitoring and providing feedback to such students [22].

Traditional Learning Content Creation and Instruction Design process is primarily owned by one party or entity. To ensure validity of content data, making changes to the system are somewhat limited and subject to stringent rules of a change management process. It does not allow one to be able to make updates fast enough. Instructional designers have to balance many role requirements in order to produce the right learning contents. Some of the most common challenges usually met by instructional designers as listed by Christopher Pappas are designing and developing powerful eLearning courses, identifying key issues, choosing the right instructional design model, managing the eLearning project, communication, dealing with people, resolving problems, and overcoming mistakes [23]. In addition, tracking revisions and releasing versions of learning contents are also great challenges for making right decision on new release, especially for non-paced courses in distance education.

Some of these problems mentioned by Pappas can be solved with the introduction of a distributed ledger framework like blockchain. Blockchain will introduce decentralization of data making the content creation data available to and owned by all parties involved. The scalability feature of blockchain can allow for fast resolution of problems and getting new features promoted to users quicker and still be able to maintain its integrity and security. Once a block is added to the chain, it cannot be modified. A new block will be created when the modification is needed the be linked to the existing block. Every block is created with timestamped generated data which can be easily traced since it will have an immutable audit trail [6, 24]. The timestamped data can help with the tracking of revisions and release versions. Blockchain security can help protects one's instructional design from being taken by others, thus improving the prevention of intellectual property [3].

The proposed system is briefly described in the Fig. 1 below. Content creators will comprise not only of the instructor or course designer but will also include learners, industry and subject matter experts, and other instructors. Using Blockchain technology as the engine for the system, it will contribute in designing and creating the learning contents. Learners will access these learning contents and perform ascribed learning activities. Using the blockchain engine, learners can provide feedback and grades on their assignments while maintaining the anonymity and privacy. Learners can also evaluate the learning content and teaching quality during and after taking the course which will immediately be communicated to the content creators and instructors. As in the student feedback, anonymity and privacy will be maintained.

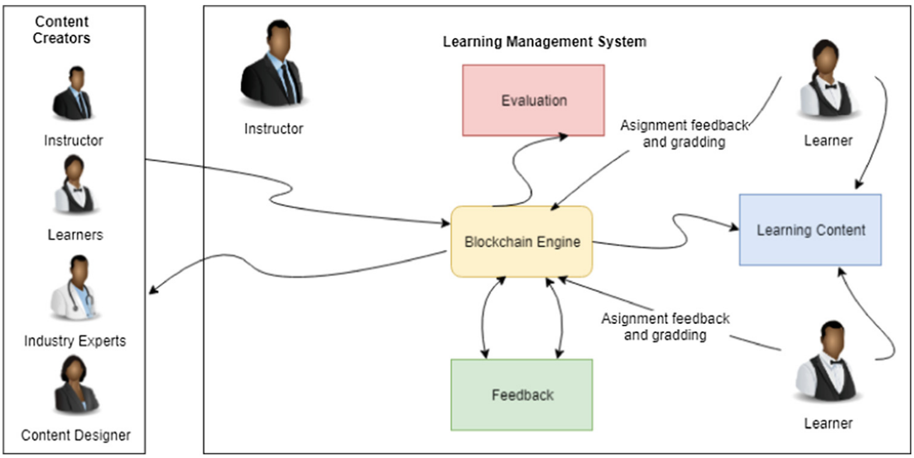

Fig. 1. Blockchain technology in education flow diagram.

All the consensus models presented above reward miners for their participation, and as such, their algorithms are thus designed with that in mind. To encourage participation and also adapt blockchain framework to learning content creation, a different approach will need to be taken when picking or creating the consensus model. There may be little or no reward in this model so care must be taken so not to push people away from participation. Some areas that may need careful consideration are:

1. Leader – Who has the most stake and right to lead and/or choose participants? Should all have and deserve equal rights and opportunities?
2. Participants – Who can participate and how will participants be trusted? One of the objectives of a consensus mechanism is inclusiveness, which states that, as many people (or nodes) as possible should be involved in the process. Can this include inputs from Big Data Analysis and Machine Learning?
3. Classification – Classify the participants based on creating various criteria and roles in learning content creation and instructional design
4. Validation – How will verification and validation take place? How can make sure each and every vote has equal weighting when participants can be of varied backgrounds e.g. subject matter experts (SME), instructors, course designers, students etc. Can any of the blockchain consensus algorithms be used for validation and verification?
5. Security – will 51% attack be an issue in such use case where participants will be somewhat known and trusted?
6. Privacy and transparency – In a permissioned blockchain where participants are known, how can the notion of privacy be preserved, and at the same time make contributions and/or inputs transparent?

5 Conclusion

Blockchain technology has successfully been used in the finance and e-commerce industries for payments and smart contracts. As stated by [4], it has the potential to create new foundations for economic and social systems. One such system is Education, which until now, has mostly seen the adaptation and use blockchain for degree and academic credential storage and verification, records management and smart contracts.

Using blockchain for learning content creation and management will make more use of blockchain technology's potential. One of the main aspects that can make blockchain work for learning content creation is the right consensus model. Since there may not be much reward for participants, the model should make participants feel welcome and appreciated and not push them away. There may be participants from different backgrounds and experience levels so the model needs to manage all inputs properly. Blockchain technology will help solve many of the instructional designer's dilemma and improve the instructional design and learning content creation process.

The presented work is the introduction of the idea of using blockchain technology in education including some of the findings and the interaction of this system. The next steps in this research will be to study consensus algorithms, particularly those created for permissioned and private blockchain platforms to learn how these can be adapted, furthermore, to modify or develop consensus algorithms for use in an instructional design and learning content creation environment. Based on the findings, a Learning Management System based on the blockchain technology will be developed.

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Foreseen More than a Century—Grand Vision Regarding Science and Technology from the Dream of Red Chamber

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Abstract. Cross-disciplinary integration is one of the most important strategies for current education and technologies development. Although literary creation and technology have always belonged to different disciplines, they have far-reaching effects on each other. This paper addresses the influence of the grand vision regarding science and technology in series of novels during the late period of the Qing Dynasty. Scholars at that time have a very strong technological vision and literary creativity. Through observing serial novels in Shanghai at that time, we learn that the demand for a large number of popular literary markets in the Beijing-Tianjin region did cause such works to be released one after another. Therefore, we should re-observe the officer's mind and people's mind during the late period of the Qing Dynasty, and strive to integrate literary thoughts and scientific education in the future world. At the same time, in a cross-disciplinary integrated knowledge system, we need to jointly develop and practice the infinite creative value of life.

Keywords: Cross-domain integration · Dream of red chamber · New Stone

1 Introduction

In the sci-fi literature of the late period of the Qing Dynasty, Baoyu Jia visited the teaching scene of the 50,000-person classroom which called the Shuishih School. Since everyone wears wireless headphones like AirPods, the speaker's voice is very close, just like leaning on the ear. Moreover, when the students of liberal art were in a lecture, students of martial arts went to the beach to perform the exercise, including the use of diving equipment for marine ecological display. This is the science and technology education environment that Chinese people hope to achieve a hundred years ago.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 589–595, 2019.
https://doi.org/10.1007/978-3-030-35343-8_62

Nowadays, we are re-reviewing these literary works, perhaps this is the beginning of rethinking education.

The rest of the paper is organized as follows. Section 2 presents the beginning of the story (Jia Baoyu reads the newspaper). Section 3 introduces the Woyau Wu who is not only a novelist but also a science buff. This is followed by the story of landing on the moon after earth travels. Finally, we conclude this work.

2 Jia Baoyu Reads the Newspaper

In one hundred and twenty chapters of “Dream of Red Mansions”, after the end of the examination, Baoyu Jia suddenly disappeared into a huge crowd of people. At the last stop in this worldly world, he appeared in PiLingYi (toponym). One hundred and fifty years later, an 18-year-old youth who once worked as an employee in a Shanghai tea house began to create a science fiction story, called The New Stone. This person is Woyau Wu, an expert who established many Shanghai newspapers in the late 19th century.

Since 1897, Woyau Wu has presided over many newspapers, including “Tzu-Lin-Hu News”, “Tsai-Feng News”, “Chi-Shin News”, “Yu-Yen News” and so on. Later, during the period of the editor-in-chief of “Yueh-Yueh Novels”, he wrote many famous literary works, such as “Bizarre Happenings Eyewitnessed over Two Decades” and changed from a founder of the newspaper to “A renowned novelist”.

In 1905, the “New Stone” by Woyau Wu is serialized on the “Southern Newspaper”. The story began after Baoyu Jia leaving home. After repeating multiple reincarnations and multiple disasters in Ching-Keng mountain. Baoyu Jia suddenly remembered the women in the Grand View Garden that year, which made him only want to go home. When he returned to the worldly world again, the strange thing he saw, at first sight, was the newspaper by Woyau Wu.

Baoyu Jia was shocked when he saw the date in newspaper. He wants to ask people where is Jin-Ling City now. At that time, there was only a man, who may be the incarnation of Woyau Wu, in the teahouse. This person only knows that there is a Ning-Kuo Mansion but he does not know if there is Rong Mansion. Baoyu’s page-boy in the side interjected: “Don’t ignore him. In Nanjing and Beijing, who would not know the social status of our Jia family? Such as Granny Liu, she is a woman from the countryside but she still can find our mansion.” The man listened and said awkwardly: “I just heard what you mentioned, do you ask about the Baoyu Jia’s mansion in “Dream of Red Mansions?” Baoyu Jia was very happy to answer: “Yes, but I don’t understand what is Dream of Red Mansions. [1–3]” The people smiled ironically: “Do you forget yourself by reading the novel? Why do you want to ask his mansion? Do you want to see Baoyu Jia? Or do you want to see Daiyu Lin?” Baoyu said bluntly: “I am Jia Baoyu.” The people in the teahouse looked at the sky, rubbed their eyes, and even more bluntly said: “Not good! I either met a ghost today or met a madman!” He summoned a young boy next to him and said, “I often say that teenagers don’t always focus on reading novels. Really, some people make fool of himself. You see that this person claimed to be Baoyu and he only asked Rong mansion, isn’t he? ”After the conversation, the people who drank tea next to them all gather round. Everyone looked at Baoyu.

The author used the approach of metafiction to describe that Baoyu Jia bought a set of "Dream of Red Mansions" that night. He saw that the book was a foot high. When he saw some names, he was secretly surprised. After carefully reviewing, he was confused and suspicious. The more he reads, the more confused he is. After reading the book, he was still very surprised.

In order to represent that life as a dream and the illusion of fictional literature for people, the novelist deliberately uses the awakening of self-awareness to let the protagonist "Baoyu Jia" watch his own story with bystander vision. This is an approach of metafiction. The rhetoric is used cleverly in this novel. Woyau Wu uses the bystander vision of Baoyu Jia to satirize the connection between the novel and reality. In fact, it really has the potential to make people falling into madness when you read novels. After teasing Baoyu Jia in the teahouse, we should enter the world of science by Woyau Wu's writing style and understand what is the dream of literary and the enthusiasm of science.

3 The Novelist is also a Science Buff

Later, Baoyu Jia accepted the suggestion of others to take a ship to Beijing and visited the new school at that time. Woyau Wu's pseudonym used in this novel is the old boy. In this story, there is a man named the old boy either. Therefore, it seems that the author writes this novel with himself as the protagonist. He made an appointment with Baoyu Jia to visit the Shuishih School. They walked slowly on the Chuiyang road. Suddenly, a big bird flew over their head! Baoyu Jia asked in surprise: "Where did this big bird come from?" The old boy laughed and said: "This is a flying car. We have invented flying cars in recent years. Therefore, there will be no cars on the road so that traffic accidents on the road can be avoided. This invention not only protects pedestrians but also saves a huge road repair fee since the road is not used! "

Baoyu Jia was very curious about the flying car: "How high can this car fly?" The old boy said: "The flying height is arbitrary. The car that travels a long distance flies higher, about a hundred feet off the ground. However, drivers in this category need a driver's licensed and can drive anywhere. If the car is driving in the city, it is only 50 feet off the ground. Although it can fly, the constant flashing of the car shadow is harmful to the eyes of people in the city."

Baoyu Jia saw the flying car and was shocked and happy: "I don't know whether there is a company like a Railways Administration. Is there a fixed driving schedule?" The old boy replied impatiently: "There is no such inefficient approach here. People don't have a fixed time to go out. If the driving schedule of the flying car is limited, how do you think this way can be convenient for pedestrians? Therefore, the flying car of this place can be taken at any time; the size of the flying car can be chosen at will. Baoyu Jia asked again: "How far can the flying car drive in a day?" The old boy said: "The express-flying car can drive 1,200 miles in an hour. We are now sitting on a slow-flying car, which is 800 km an hour. We are a hundred miles from the Shuishih School and can be reached in about 15 min."

Baoyu Jia watched on the flying car through the glass window. He was ecstatic unwittingly when he saw flying cars of, different sizes in the sky. However, the old boy said: “The flying car is still in the research of improvement. After we visited the Shuishih School today, we will travel to other places tomorrow. You can take a hunting-flying car and hunt in the sky.” Baoyu Jia did not expect that the people can take a flying car to hunt!

Then Baoyu Jia and the old boy got off at the front of the Shuishih School. They saw that the school had tall walls and painted walls, which were magnificent. They walked through the student house and cafeteria before they arrived at the lecture hall. Outside the lecture hall is the playground. The playground is very wide and boundless. Today’s teacher is Shengwu Sun. He said to Baoyu: “This class has not yet begun. There is an auditorium in the lecture hall. You can go there to audit that class.” The old boy said: “The auditorium is too close to the lecture. We have to sit far away this time. It is best to use a headphone.” Therefore, Baoyu Jia’s seat was changed from the auditorium to the last class seat.

There are usually 50,000 students in this lecture hall so that there are 50,000 chairs. When Baoyu Jia entered the lecture hall, he saw a wide and deep space. Although the house is full of students, it is very quiet. Baoyu Jia put on headphones. Shengwu Sun began the lesson. He was very surprised that he really heard the voice of Sun Shengwu as if he was talking in the ear! This lesson is about the skills of offensive and defensive, which makes Baoyu be as fresh as a daisy. After this lesson, Shengwu Sun said: “We are going to the beach to practice, you can go visit together.” Baoyu Jia said: “It’s great, it’s rare to have this opportunity. How far the beach is from here?” Shengwu Sun said: “About 50 km, it will soon arrive here if you taking the flying car.” Then, Baoyu Jia saw that countless flying cars were arranged there, and all the students were getting on the flying car. This car is different from the previous one. It is a convertible flying car and has railings on all sides. It can accommodate twenty or thirty people. Baoyu Jia asked: “What should I do on a rainy day?” The old boy said: “Of course, when it rains, you can raise the shed” At this time, the propeller rotates quickly and countless flying cars take off. A large group of flying cars flew east.

Although these flying cars are flying in the air, they are also lined up neatly. Baoyu Jia walked to the side of the railing and looked down to see the mountains and rivers at the bottom of the foot. Baoyu smiled and said: “Flying up to the cloudy regions in the novel seems to be just like this.” The school introducer said: “The ridiculous Europeans and Americans have invented the cumbersome and dangerous balloons and bragged continuously! How do the flying up to the cloudy regions mentioned in ancient novels can compare to our flying car?

After Baoyu Jia got off the coaster, he experienced the practice of Shuishih School on the beach and experienced the power of the “permeable mirror”. They were still in Asia the day before and they were already in Africa the next day. In fact, the hunting-flying car is flying to Central Africa for hunting. Soon after, Baoyu Jia took a submarine from the Atlantic Ocean to the Pacific Ocean. He traveled around the earth for a week and he took a glimpse of the wonders of the underwater world.

4 Landing on the Moon After Earth Travels

In fact, the year before Woyau Wu wrote "The New Stone", in 1904, Nianci Xu had published "The Moon Colony Novel. The story originated from a murder case that occurred in the late period of the Qing Dynasty. Hunan's Menghua Long fled and succumbed to murder. On the way, with Japanese friend Yutaro Fujita, taking an air warship to circumnavigate around the earth. Finally, he landed the moon to find his wife and children. The public transportation which Menghua Long usually take is "balloon", mentioned in "New Stone." The novelist pointed out: "When you go inside the balloon, the exquisiteness of the machine is really never seen before. In addition to the airlock, there is a living room, a physical playground, a rest of the bedrooms, and large dining rooms, you name it!" Later, Menghua Long and Yutaro Fujita discovered that the balloon driven by the Moonman was more advanced. It not only fast but also able to sail away from the gravity in the space. At the end of the story, Menghua Long moved to the moon to live, and Yutaro Fujita decided to stay on the earth to improve his "balloon".

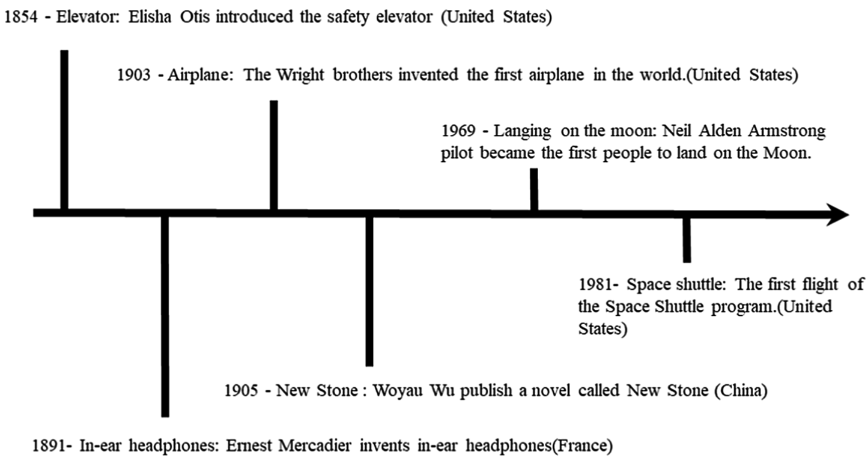

Fig. 1. The development schedule of technologies for nearly 100 years.

Science fiction has always been an amazing prophecy. Since the late period of the Qing Dynasty, more than a hundred years ago, air traffic has not completely replaced the transportation system on land. The two wings of the plane are still there. However, mobile long-distance vehicles that do not have reservations in advance and are waiting in line to travel at any time seem to exist only in novels one hundred years ago. Lecture halls that can accommodate 50,000 people are also rare. The training course at the beach is like a dream. In addition, the last class was still in the urban area and the next class came to the beach. The journey to both places takes only five minutes by flying car. As for the late period of the Qing Dynasty, Menghua Long with his wife and children freely immigrated to the moon, which is as illusory as a mirage. The Chinese were afraid of the atrocities of the rulers and moved to the moon, but the Japanese chose to stay on the earth to continue his research. Figure 1 show the development schedule of technologies for nearly 100 years. In fact, we observe that the novelists have mastered the pulsation of politics, technology in the past, and the national personality of different countries.

Table 1. Comparison of the grand vision regarding science and technology from the dream of red chamber and the current technology

Grand vision regarding science and technology from the dream of red chamber	Current corresponding technologies and products	
Flying car	Airplane [4]	Yes
Elevator	Elevator [5]	Yes
Headset	In-ear headphones [6]	Yes
50,000 people classroom		No
Bus without schedule		No
Convertible airplane		No
Balloon	Space shuttle [7]	Yes
Landing to the moon		Yes

Table 1 shows the comparison of the current technology and the grand vision regarding science and technology from the dream of red chamber. Although some of the scenarios may not be realized yet (50,000 people classroom and bus without a schedule), many of the technology applications are indeed consistent with the current situation.

5 Conclusion

Cross-disciplinary integration is very important for current education and technology development. This study explores the literary works in the late period of the Qing Dynasty and the development of current science and technologies. We find that many applications of science and technology have been foreseen as early as 100 years ago. It also confirms that the scholars of the late period of the Qing Dynasty actually have a very strong technological vision and literary creativity. These literary creations may directly or indirectly affect the technological development of later generations. In the future, we need to focus on the convergence of literary thought and science and technology education, and jointly develop and practice the infinite creative value of life.

Acknowledgment. This work was supported in part by the Ministry of Science and Technology of Taiwan, R.O.C., under Contracts MOST 106-2511-S-259-001-MY3.

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Innovative Technologies and Learning in a Third-Year Computing Module

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Abstract. Innovative technologies and learning in a third-year Computing module, especially when providing open access to education and learning, served as the rationale for this study. The aim is reporting on findings from the pilot phase of a Student Module Evaluation (SME). The authors review applicable theoretical conceptual frameworks, and literature into teaching and learning, addressing the challenges of computing education in an Open and Distance e-Learning (ODeL) environment. The mixed-methods methodology resulted in mainly quantitative findings, with qualitative findings providing details regarding what students enjoyed about the module, whether students prefer it presented as a year module, how the module can be improved, and further comments. The findings provided data towards the aim of evaluation and improvement. Regarding possible future work, following the outcome of this pilot, full-scale roll outs of SMEs are planned, employing an automated tool. The significance of the paper lies in presenting original work contributing to debate in the fields of ODeL and technology enhanced learning, closing research gaps.

Keywords: Open access to education and learning · Pedagogies for innovative technologies · Technology enhanced learning

1 Introduction

Even though the majority of data presented in this paper will be quantitative, as philosophical point of departure and lens through which the authors examined the practice of research, the underpinning paradigm prescribing this study is an interpretive one, leading to the authors taking on more subjective, participatory roles [1].

In an environment where enterprises are increasingly moving towards digitization, enabled through unified communication and collaboration technologies [2], Cant and Bothma [3] discussed the e-learning technology conundrum from lecturers' perspectives, while Goosen and Naidoo [4] provided feedback on how computer lecturers from the university [5], and specifically in the College of Science, Engineering and Technology (CSET) [6], were working in partnership to promote the continued support of innovative technologies, specifically as is relevant for Open and Distance e-Learning (ODeL) across Africa, as well as possibilities for keeping Information and Communication Technology (ICT) education relevant [7]. As pointed out by Ngugi and

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 596–605, 2019.
https://doi.org/10.1007/978-3-030-35343-8_63

Goosen [8], many such existing studies, although undertaken in a higher education institution setting, have not focused on students. Goosen and Naidoo [9] therefore expressed the opinion that further research should be conducted, in order to better understand feedback from specifically students, as to which e-learning technologies they felt were most suitable for facilitating effective teaching and meaningful learning amongst third-year Information and Communication Technology (ICT) students. By disseminating the results of a Student Module Evaluation (SME), Goosen and Naidoo [10] took steps in the right direction in this regard, providing third-year students' perspectives on the state of educational technologies on an ICT module. While Goosen and Naidoo [11] specifically looked at e-learning in an ODeL environment, the current paper provides a more complete view, including qualitative responses from students.

Educational technologies for the 21st century [12, 13], and ICTs can be used effectively to facilitate the teaching and learning of academic areas [14] for undergraduate Computer Science or Information Technology modules in an ODeL environment [16].

The statement of problems, especially as applicable to the emerging area of ICT [17], and as reported by researchers such as Goosen and Van Heerden [18], around effectively teaching and meaningfully learning for addressing challenges related to an ODeL environment at the University of South Africa (UNISA), served as the rationale for the study reported on in this paper. The aim of the study is to report on the findings of a research project conducted as the pilot phase of a student module evaluation undertaken by the Directorate of Institutional Research (DIR) in September/October of 2014. This aim was targeted in order to address the research question: How can innovative technologies be used to support the learning of third-year ICT students in terms of open access to education and learning? This new focus that the authors decided on also covers classically observed problems relating to monitoring progress and highlighting limitations and/or areas for improvement through student feedback.

Due to the didactical principles being integrated meaningfully into teaching and learning various modules [19], such as the one discussed in this article, Goosen, Mentz and Nieuwoudt [20] recommended that higher education institutions should consider whether particular modules complied with educational aims regarding the preparation of students towards having a firm foundation in suitable practices, such as social, life and organizational skills [15].

The institutional Senate Teaching and Learning Committee therefore requested that a system be introduced, which more frequently evaluated student modules. The objectives of such surveys not only included piloting the data collection instrument for the student module evaluation system, but also to provide an overall picture by focusing on the students' views and experiences of the modules, to provide data for improvement.

In agreement with Goosen and Pieterse [21], it is believed that by analysing this information, suggestions can be formulated to improve student support for a third-year ICT module at a distance – this could be done together with ideas for best practice as provided in applicable related literature, also including that, which presents opportunities for further investigation.

Reviewing literature on research into effective teaching and meaningful learning to address the challenges of ICT education, in some cases in open and distance e-learning environments and/or for studies conducted at UNISA, as well as applicable theoretical and conceptual frameworks, was another of the objectives of this paper.

2 Theoretical and Conceptual Frameworks

According to Oblinger [22], it is important to understanding the 'new' kind of students coming into higher education institutions these days - in this regard, generational theory as described by Wilson and Gerber [23] was used to contribute towards student support for retention and success, proving strategies to work with these so-called 'millennials'.

Simpson [24] asked whether we are failing our students with regard to support for retention and success in open and distance e-learning. More specifically, the 'Transactional Distance' theory suggested that there is an intrinsic distance between students, institutions of tertiary education and their e-tutors, which contributes to a lack in terms of communication between them - thus making dropout more likely. Simpson [24] went on to explain that if this theory was part of explaining the open and distance e-learning deficit, then the theory implied that improving interaction between students, their e-tutors and the institution of tertiary education would improve student retention. The latter author, however, was of the opinion that many open and distance institutions of tertiary education confuse teaching with learning: Institutions of tertiary education had focused too much on providing especially online teaching materials, and too little on the motivation of students to actually learn. There are benefits to proactive contact to overcome dropout, together with the significance of making such contact motivational.

Further towards student support for retention and success, Stevenson, MacKeogh and Sander [25] worked with student expectations of e-tutor support in an ODeL environment to test an expectations-led quality assurance model. These authors explained that students come to open and distance e-learning modules with varying expectations regarding the service and support levels they would receive from their e-tutors. Earlier work by these authors further recommended that specifically, expectations-led quality assurance processes, which enabled sharing of such expectations before a module started could be mutually beneficial to the student and the e-tutor. They also argued that this ought to have advantageous effects, as it could reduce student drop-out and increase module completion rates.

3 Literature Review

The affordances and acceptance of both established and especially emerging technologies to support ICT students at a distance is explored, as well as what can be done in terms of curriculum development, pedagogy and assessment, to improve student support for retention and success. Related literature, which presents opportunities for further investigation, included Boyle, Kwon, Ross and Simpson [26], who looked at student-student support, in the form of mentoring, as this could still have a lot to offer when it came to increasing retention, engagement and success in an open and distance e-learning environment. Students in their study valued opportunities for having regular contact with a knowledgeable mentor. They experienced such contact as encouraging and motivational, enabling them to deal increasingly more effectively with demands related to their studies and feeling that they formed part of a learning community. Such contact, occurring at important decision-making points in students' progress through their modules, assisted them with identifying issues, which might be barriers to successfully completing and providing opportunities to resolve these in a timely way [26].

Fung and Carr [27] investigated how students' needs, in terms of support for retention and success, could be met using face-to-face tutorials in an open and distance e-learning system. These authors investigated how students' needs in terms of support for retention and success could be met by using face-to-face tutorials in an open distance e-learning system. According to these same authors, a successful open distance education system typically included elements of face-to-face teaching. This formed an important component for supporting student progress through the instructional materials. The United Kingdom Open University advocated that tutorials be participatory events, instead of straight lectures. Such an approach reflected the educational philosophy, in which deep learning required students to be actively engaged in the learning process, instead of passively receiving transmitted teaching. In their research, Fung and Carr [27] also found that students valued academic support from their e-tutors. These tutors enhanced students' understanding of the module materials and provided broad guidance on their assignments.

Onyancha [28] indicated how students could be profiled via an institutional information portal. Although this research was carried out at UNISA, that population consisted of Bachelor of Arts degree students, as opposed to the Bachelor of Science students for this research.

4 Research Methodology

4.1 Research Design

As also described by Goosen and Naidoo [4], with regard to the appropriateness of the methodology, a mixed-method study was used in the research reported on in this paper. Involving the collection of both quantitative and quantitative data, similar to what was previously reported by Onyancha [28], the current study was a descriptive one.

4.2 Data Collection Instrument

For the pilot study, an online survey tool, Qualtrics, was employed. The tool is not specifically designed for module evaluation, but serves as an interim measure until a dedicated tool is secured through a procurement process. The datasets and reports generated were automated, each specific to a particular module.

A PDF version of the data collection instrument could be accessed online for the module lecturer's convenience and to support data analysis. Lecturers were free to share the data collection instrument with their colleagues who wish to conduct their own student module evaluations.

The module discussed in this paper is called Information Administration 3 (Theory), with module code IAD3701. It is a third-year major for the Diploma in Office Management and Technology and is therefore also an exit level module. The curriculum covers Supply Chain Management (SCM), Enterprise Resource Planning (ERP), e-business, outsourcing, project management, innovation, etc.

4.3 Sample and Sampling Technique

Surveys reflected on in this paper were conducted online across all colleges (faculties) at the higher education institution referred to in this investigation, encompassing a total of 81 modules and generating some 6800 responses from students. The applicable modules were all second semester and year ones. Similar to the study reported on by Goosen and Pieterse [21], this paper also represents students' perceptions.

The population for the module specifically discussed in this paper consisted of all 57 students registered for the module at the time when the survey was carried out. They were all invited to take part in the survey. Of these students, only nineteen responded (appear in the corresponding data file) - no more than sixteen at a time, however, supplied data for any specific item in the survey. It should be noted that as the surveys were conducted online, not all students registered for the module could be contacted.

4.4 Validity and Reliability of the Instrument

In the collection of qualitative data, as argued by Maree and Van der Westhuizen [1], the authors of this paper found that the in-depth responses from individual students secured sufficient levels of validity and reliability, although another argument is that such grounds are insufficient to ensure trustworthiness and validity. As suggested by a number of authors, we also paid attention to dimensions including dependability, confirmability, credibility and transferability, in order to increase the trustworthiness and/or reliability of especially the qualitative aspects of the study. We further found that it was good to explain briefly which criteria were used to content validate the instrument against.

Especially aspects related to qualitative research required using various strategies for enhancing validity, which included obtaining external coding services, for verifying the qualitative findings. As described by Maree and Van der Westhuizen [1], reliability with regard to the qualitative aspects of the study is represented by those findings, which are consistent with data collected.

As also mentioned in Goosen and Naidoo [4], especially for the quantitative aspects of the research, validity includes issues related to reliability [29].

4.5 Data Analysis

In some cases, very few responses were collected - this was either due to the small number of registered students for the particular modules and/or no email details being available for the students. It was, however, felt that the data, particularly qualitative feedback, may still be of use to the module coordinator(s), and were therefore provided. The reader should note that this data was analysed and interpreted with caution, as it was not necessarily representative of all students.

5 Discussion and Analysis of Results

The findings shown in Goosen and Naidoo [11] related to students' evaluation of their interactions with their e-tutors (see Table 10) indicated that their expectations in terms of the quality of e-tutor support had been adequately met, as had been explained by Stevenson et al. [25] in the latter authors' expectations-led quality assurance model.

The findings reported by Goosen and Naidoo [11] with regard to the module being well-structured (see Table 13), and the overall mark allocation for the module was clearly explained (see Table 14), the guidelines for assignments having been adequate (see Table 14), and the guidelines for portfolio preparation having been adequate (see Table 14), show that one of the pedagogical adaptations, which had been recommended by Wilson and Gerber [23] in terms of generational theory, was used to contribute towards student support: the clarity of module structure and assessment were enhanced.

Goosen and Naidoo [11] also displayed students' opinions about the amount of communication they received for this module varied widely, with just over a third each (5; 36%) respectively indicating that it was 'far too little' vs. 'about right' (see Table 15). This set of findings suggests that even more could be done in terms of implementation to negate the effects of the 'Transactional Distance' theory suggested by Simpson [24].

5.1 Qualitative Results in Terms of Open Questions Asked of Students

Please note that an effort was made to supply as much as possible of the following in students' own words, as to add to the authenticity - spelling, grammar and punctuation, in many instances, however, needed attention…

Would you prefer if this module was presented as a year module? Motivating why they would **not** prefer that this module be presented as a year module, students responded that it was "good" (in its current semester format), "because if you failed in the first semester, you have a chance to complete that same year." This sentiment was echoed by another student stating that if "you are given the wrong information about the tutor concerning the examination, then you will have to wait whole year again to do the module." One student expressed the opinion that "the time allocated is adequate so I don't see the need for it to be a year module as it is technology module". Lastly, and seemingly rather preferring the year option, one student indicated that (s)he found "it difficult to pass this module. There is a lot of information in the prescribed book and is not easy to capture everything." Another student also selected the current semester format, but indicated that "it would be difficult for me to get enough time to study as" I "am working 6 days a week".

In terms of motivation for those students who did prefer that this module was presented as a year module, one student indicated that assessment 3 for the "portfolio needs more time and understanding and some of the" stuff "I don't know how to do them I end up leaving blank spaces should I have more time I would want to finish the assessment and not leave spaces". Equally, other students reported that it "is quite a lot to study in such short period of time", it "needs more time to prepare" and it "has so much work, I think students will perform better with more time on their hands to prepare." Finally, two students replied that "because we can be able to learn more about the module and do more practical side of this module" and "because we will get more knowledge about the modules".

What did you enjoy most about the module? Two students agreed that everything "about it" and everything "was just a good learning experience that I can take with to the work place." Three more students answered with regard to learning "more about overall technology that I never knew and 21st century technology that's exciting and mind boggling", how "to use my understanding in the new technology world and easy to use at" any time and "I learned more about technology since I am working in a business environment and the module is in line with my work experience". Another enjoyed this module, "because now I have some knowledge about what is going about the computer and I enjoyed doing practical side of the module", while "it taught us to know about the theory part of the computer and the benefits of a business and its challenges if you want to start a business of its so important to know all of these". Finally, three other students mentioned two topics "e-commerce" and "supply chain management", while another enjoyed the multiple-choice questions.

How can the module be improved? At least one student was quite positive bay replying "None". Another commented that the module can be improved "by not giving us so many chapters to study in a short space of time", which is echoed by another indicating that "by giving us more time and adding an online skype tutor" and/or "for things that are not understandable or anything that one does not understand". Yet an additional student reacted with "by giving scope when writing examination", while one more again reiterated by "taking it back to a year module".

Some of the students felt that "if there can be a tutor every weekend to help with some queries that some students have and give some guidelines through face-face sessions", "by providing" a "class tutor every Saturday", by allocating e-tutors and by letting "us do more practical and attend classes for this module". Latching on to the last comment, another student suggested that it "will be fair for students if this module can only be offered practically."

The computer lecturer should not focus only on one chapter for the examination - allegedly, most students were complaining about this - the student believes that "only less important units are the ones used for" the examination. This would be very "unfair to the students," who "do assignments as preparation for" the examination, "but not even" a "single part of' the assignments "is included in" the examination.

Further comments: According to one of the responding students, this is a practical module that "is too difficult and needs more time', "even if only the practical" part of it could be "a year module that would be much appreciated". Another student echoed that studying "the whole (text)book is very difficult." Sadly, one of the students reported that "since I started this module", I (have) never passed "it from the first" attempt. "I repeat a module for several times before I can pass it."

Yet another student wanted "more engagement with follow students who wanted to post certain issues related to this module" - presumably on the discussion form? Again, some of the students felt that "it will better if we can have Saturday classes, especially for this module" ICT3, while another's comment was "that tutors must be provided."

In contrast to previous results showing that most students had reported receiving feedback on their assignments promptly, one student did ask "give us the feedback and assignments marks on time so that we can see how we perform in our assignments".

6 In Conclusion

Problems that emerged around the effective teaching and meaningful learning of ICT, especially when this occurs in an ODeL environment, led to the study reported on in this paper. The main findings of the student module evaluation reported on in this paper were quantitative, e.g. regarding respondents' demographics, while qualitative findings provided details regarding what students enjoyed about the module, whether students prefer if this was presented as a year module, how the module can be improved, and further comments. These findings provided data to highlight limitations, issues not being addressed and shortfalls, and monitor progress through student feedback.

In terms of generational theory [23], findings showed that the enhanced clarity of both module structure and assessment contributed towards ICT student support at a distance. Findings regarding students' opinions about the amount of communication they received for this module, however, suggested that even more could be done to support ICT students in terms of negating the effects of the 'Transactional Distance' theory suggested by Simpson [24]. Finally, the findings displayed that with regard to the expectations-led quality assurance model explained by Stevenson et al. [25], e-tutors can provide quality support to ICT students at a distance.

Similar to what was described for the paper reported on by Goosen and Breedt [30], the merit of the research study also proved to be of relevance to this International Conference of Innovative Technologies and Learning (ICITL'19) with regard to showing the affordances and acceptance of established and emerging learning management system technologies, as well as by being justified in terms of the frequent changes associated with learning management system technologies that computer lectures have to contend with. The findings also show a depth of research that makes an original contribution to academic debate regarding areas for the improvement of student support for retention and success, and specifically to ODeL, by presenting students' perspectives on, for example, their access to an ICT module.

With regard to suggestions towards possible future foci in terms of such student module evaluations, following the outcome of the 2014 pilot, a full-scale roll out of student module evaluations can be planned to employ an automated tool. This would, however, be contingent on a successful tender process.

Please note that more information on the research method used, as well as additional discussion and analysis results related to ensuring that the research question is answered, are provided in Goosen and Naidoo [4, 9, 10] – the latter specifically provides all of the tables referred to in this paper.

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Teachers' Beliefs About Technology in the Classroom from Early Implementation Phase in 2003 to Contemporary Practise in 2016

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Abstract. As a recognition of the importance of teachers' beliefs for developing robust ICT use in the schools, this paper investigates how teacher beliefs have changed from the implementation phase in the early 2000s and up to present time. Utilising data from the national Norwegian survey "Monitor school", variables on the amount of ICT used by teachers in the classroom are used as predictor for the teachers' beliefs about technology. The data is drawn from 6 datasets (2003, 2005, 2007, 2009, 2011 and 2016) and encompass 3032 teachers in 7th, 9th and 2nd upper secondary grade. Three variables of teachers' beliefs about technology covers aspects of ICT and differentiation, variation and motivation. The findings point at the fact that teachers already in 2003 were positive towards technology, but that their beliefs about the benefits of using ICT in teaching increased substantially between 2005 and 2007. Furthermore, the impact of teachers' use of ICT on their beliefs is seen only with a moderate, although significant estimate.

Keywords: Teachers · Beliefs · ICT

1 Introduction

Researchers often point at the teacher as the most important factor influencing educational outcomes. Hattie [12], for instance, dedicate one entire category to teacher effects. While student effects unsurprisingly account for the largest proportion of variance of learning output, teacher effects are the second most important source [13]. Researchers might oppose to the rather positivistic way of treating learning that effect-research might imply, but still agreeing on the importance of the teacher [3]. Teachers are often seen as key factors for successful changes in the schools. This is also true when it comes to implementation of technology and didactical changes in this regard. Many reports point at a lack of skills among teachers when implementations fail or progress slowly. However, the attitudes of teachers towards technology is less studied, while still often being seen as a similarly important aspect as skills. Teachers' beliefs

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 606–615, 2019.
https://doi.org/10.1007/978-3-030-35343-8_64

about technology, how they can benefit from it, and how technology «fits» their beliefs about teaching in general, are important aspects when discussing teachers' attitudes towards technology.

Ertmer [8] argued more than a decade ago that most factors for successful and high-level use if technology in the schools were in place in the USA, but that there was one critical barrier left: teacher's pedagogical beliefs about the use of technology in teaching. The conditions were probably similar in Norway in terms of available computers, several large-scale initiatives and national strategies and increasing in-service professional development courses for teachers. Pajares [18] argues that teachers' beliefs «(…) can be the single most important construct in educational research» . He further highlights the fact that beliefs are about *something*:

«… beliefs about confidence to affect students' performance (teacher efficacy), about the nature of knowledge (epistemological beliefs), about causes of teachers' or students' performance (attributions, locus of control, motivation, writing apprehension, math anxiety), about perceptions of self and feelings of self-worth (self-concept, self-esteem), about confidence to perform specific tasks (self-efficacy). There are also educational beliefs about specific subjects or disciplines (reading instruction, the nature of reading, whole language)» [18].

It is difficult to describe teacher beliefs in explicit terms considering the many of ways they have been defined in the research literature [17]. Still, Pajares comes close to a definition of beliefs:

«The result is a view of belief that speaks to an individual's judgment of the truth or falsity of a proposition, a judgment that can only be inferred from a collective understanding of what human beings say, intend, and do» [18].

Van Praag and Sanchez [21] separate incentives and barriers into two categories: internal and external. Internal incentives and barriers refer to teachers' beliefs, while the external category refers to context factors like time and support.

A review of the relationship between teachers' beliefs and use of ICT [20] synthesize five statements. First, the relationship between teacher beliefs and use of ICT is bidirectional. Through iterations teachers both improve their use if ICT and change their beliefs about ICT. Second, teacher pedagogical beliefs might act as a barrier to the development of ICT use. Third, teachers' beliefs about teaching is context bound. Still, specific pedagogical beliefs are related to specific practise. Statement four points at the fact that not all professional development initiatives are successful to all teachers and that those initiatives that lasts some time might be more effective. Statement five highlights the importance of support and a vision about what good teaching is. Student-centred teaching is highlighted in this regard. Uncovering the complexity of teachers' beliefs and use of ICT, the review concludes:

«Consequently, the process of effective technology integration should not be facilitated as a stand-alone event, focusing solely on technical skills. Based on the results of this study, teachers' beliefs about "good" education should be a critical dimension in professional development programs that support teachers learning about the meaningful use of technology in education.» [19].

Teachers of different subjects might hold different beliefs about technology. In a quasi-experiment, Chiu and Churchill [4] found that their intervention on teachers' beliefs, attitudes and feeling of anxiety and a positive impact on mathematics and science teachers, but not on language and humanities teachers. Admiraal et al. [1] conducted a cluster analysis and found five teacher types: Type 1: learner-centered teachers with technology, type 2: teachers critical of technology use in school, type 3: teachers uncomfortable with technology, type 4: teachers uneasy with learned-centered teaching and type 5: teachers critical of a clear-cut stance.

In 2006 an educational reform, the «Knowledge promotion» [16], was introduced in Norway. With this reform, ICT skills were defined as a basic skill along with reading, writing, oral skills and basic mathematical skills. ICT was integrated in the curriculum to much larger extent. It is fair to expect that the reform marks a clear change and that the use of ICT before and after 2006 are based on rather different expectations from the political level.

The present study aims at documenting a possible change in teachers' beliefs about and attitudes towards technology. The research question guiding the paper is:

"How have teachers' beliefs towards technology changed over time?"

To investigate the research question the paper makes use of data from the national survey "Monitor school" in Norway [5–7, 10, 14]. Three items concerning teachers' beliefs and attitudes towards technology are present in all or nearly all volumes of Monitor school. These three items all relate to teachers' perception of how technology can improve their teaching. The first item concerns the matter of differentiating teaching. The principle of differentiation is stated clearly in the Norwegian Educational act, § 1.3. All students have the right to receive teaching according to their potential. Monitor included an item concerning differentiation long before the notion of «personalized learning» became a buzzword in educational technology (shortened with another buzzword «Ed Tech»). The second item measures to which degree the teachers believe that technology can motivate students. Motivation has long been seen as a key factor in learning with various definitions and constructed attached. The idea that technology might improve motivation has been an argument for a long time. The third item is related to variation. ICT can provide almost indefinite amounts of media content, learning resources and information sources. Furthermore, technology can give new possibilities for traditional methods and also open up for new ones.

2 Methods

The Monitor survey was introduced in 2003 [14] and followed by biannual surveys in 2005 [7], 2007 [2], 2009 [10], 2011 [5], 2013 [9], and then in 2016 [6] in a repeated cross-sectional design. The survey investigates the state of affairs in terms of the use of technology in various subjects, pupils' and teachers' digital literacy, attitudes towards technology, digital maturity and priorities. The first six reports surveyed pupils, teachers and school leaders from a representative national sample covering grades seven, nine and second grade upper secondary. The 2016 survey was limited to 7th grade but follows the other surveys in other aspects.

The datasets are weighted using three strata (location, size and type of school). The reports of N and degrees of freedom in the following analyses must be interpreted with this in mind.

2.1 Sampling

Monitor draws from a representative national sample. For the first six surveys (where three grades were included) 300–400 schools participated, while for the last survey (only one grade) 106 schools participated. The response rate for each survey is typically between 60% and 70% on school level, with an exception for the 2013 volume, which had too low participation among teachers. For this reason, Monitor 2013 is omitted from our analyses. Due to the sampling strategy where the head teacher picks one class on the relevant grades, it is impossible to calculate the response rate for each response group. In most cases it is full classes that are missing which reduce the effect of missing somewhat compared to missing on the individual level.

2.2 Instruments

A questionnaire was developed for each of the three response groups (pupils, teachers, leaders). Data was collected from teachers' self-reports on Likert-type questionnaire items. Some topics are similar across questionnaires, while others are developed specifically for each group. Over the years the questionnaires have changed significantly. This makes comparative studies on item level difficult. The reason for the changes rest both in the fact that the use of technology in the schools have changed substantially, both in form and magnitude, but also as a result of an interest of improving the instruments. However, some items are the same over the years.

'Beliefs in ICT' were composed of three single items:

- ICT makes it easier to differentiate teaching
- ICT makes teaching more varied
- ICT makes it more motivating for students to learn/I use ICT to make students more interested in the subject

We used the scale 1-Fully disagree, 2-Partially disagree, 3-Partially agree, 4-Fully agree. The items measuring whether ICT makes differentiating and varying teaching easier or not, use the same wording in all volumes, while the last about whether ICT makes it more motivating for the students or not has been worded differently. While motivation is different from making students interested, these alternatives touch upon the same concept of perceived motivation.

A single item measuring the hours of ICT in teaching used during a typical week:

- Time used on ICT in teaching

An 8-point Likert scale with 1-'No use', up to 8-'Thirteen or more hours' were applied to this item. The 2003 data used a different scale, and the variable is omitted.

'Don't know' answers, or not any answer, are includes in the figures calculated in Table 1, but were coded as missing data in the subsequent statistical analysis.

2.3 Analysis

For analysis of reliability, we used 2016 data and computed Cronbach's alpha for all subscales as a measure of internal consistency. The Cronbach's alpha measures yielded a value of alpha of 0.86 for 'Beliefs in ICT'. This described the extent to which all the items in the construct measured the same concept and is very good considering only three items make up the scale. Inter-item correlations range from 0.61 to 0.76 – also entirely satisfactory. Hence, it seems fair to conclude that the three items touch upon the same construct, but still measuring slightly different aspects of it.

We performed descriptive statistics, and correlation analyses to look for associations between the variables. As correlation coefficient, we applied Spearman's rank correlation coefficient, since our data are in rank order (ordinal scale). Finally, regression analysis was carried out with 'Use of ICT' as the dependent variable. This model examines to what extent 'Year' and 'Beliefs in ICT' contribute to the result. All the analyses were performed using SPSS ver. 25 (Mac/PC).

3 Results

In this section we emphasize three indicators of teachers' beliefs about technology. These three indicators have been used in all or nearly all volumes of the Monitor surveys. Before we turn to the three main items, we will present a few figures from the early Monitors that were dropped in later volumes. These items are interesting both in their selves but also because they inform about what was believed to be relevant in the early implementation phase of ICT in Norwegian schools.

In 2003 44.5% of the teachers answered «agree» or «partially agree» to the question if students know more about ICT then them. Two years later this figured was a little lower at 42.9%. Even though this item not clearly relate to use of computers at school, the arena where teachers can assess the students' skills is still at school.

43.5% of the teachers in 2003 agree fully or partially to the question about ICT having little effect on the students' achievements in the subjects. In 2005 the figure is little lower at 41.5%. Reversed, more than half of the teachers in the mid 2000s felt that ICT could improve the students' achievements.

In 2003 58.8% of the teachers agreed fully or partially that the value of ICT in teaching was greatly exaggerated. In 2005 the same item produced a figure of 54.7%.

In 2003 the majority of teachers found that ICT made it easier to differentiate, three out of five agree to this statement. Two years later this figure increases to 63.2% before making a marked leaped to 81.7% in 2007. The following years the belief that ICT is suitable to differentiate teaching is rather stable even somewhat increasing.

Table 1 presents the development of how teachers view technologies value in their teaching from 2003 up to 2016. Three items are presented as indicators of teachers' beliefs: ICT to differentiate, motivate or to vary teaching.

Table 1. The table shows the percentage of teachers who fully or partially agree that ICT makes it easier to Differentiate/Motivate/Vary their teaching at school.

Year	2003	2005	2007	2009	2011	2016
Differentiate	59.3	63.2	81.7	81.2	83.7	88.2
Motivate	82.0	84.7	–	91.6	93.3	94.1
Vary	69.4	75.4	91.0	91.8	95.1	98.5

In terms of using ICT to motivate students, already in 2003, the majority of teachers, 82.0%, agreed to this. From this high figure, the trend is positive with a 2016 figure of 94.1%.

Teachers' beliefs that ICT makes it more motivating for students to learn. 2003–2005 and 2016 use the term «motivating», while 2009–2011 use the term «make the students more interested in the subject». Percentage that fully or partially agree has increased from 82.0 to 94.1 over the years.

The question of whether ICT is suitable to make teaching more varied are positively answered already in 2003, 69.4% of the teachers agree to this claim then. Two years after a higher figure of 75.4% is presented, but then in 2007 a marked change is seen as 91.0% of the teachers agree. From this high level, the following surveys still show some increase.

Table 2. For each year, the table shows the sample size (N), mean value and standard deviation (SD) for teachers beliefs in the use of ICT in teaching, and mean value and SD for the reported use of ICT in teaching at school (where 3 = '1/2–1 h a week', 4 = '1–3 h a week' and 5 = '4–6 h a week'). A different scale was used in the year 2003, hence data not shown.

Year	2003	2005	2007	2009	2011	2016
Sample size (*N*)	984	759	322	462	369	135
Teacher beliefs Mean (*SD*)	2.97 (.61)	3.02 (.59)	3.31 (.61)	3.32 (.56)	3.33 (.54)	3.41 (.46)
Use of ICT Mean (*SD*)	–	3.54 (1.54)	4.03 (1.45)	3.35 (1.44)	4.75 (1.59)	4.49 (1.57)

Table 2 presents the collapsed variable on 'Beliefs' in the pedagogical use of ICT at school, together with the variable on how much time 'ICT is used in teaching' on an average week. 'Beliefs' is increasing each year, with a jump between year 2005 and 2007. The use ICT in the classroom rises throughout the period, but there is a deviation in 2009 where a sudden drop is surprising.

A bivariate correlation between use of ICT, Teacher beliefs and year show the relationship between use and beliefs over time (Table 3).

Table 3. Correlation between the variables.

	Year	Teacher beliefs about ICT
Use of ICT in teaching	0.21[a]	0.25[a]
Teacher beliefs about ICT	0.28[a]	

[a]Correlation is significant at the 0.01 level (2-tailed).

The conducted correlation analyses (Table 3) reveal interesting associations between the variables. The 'Use of ICT in teaching' variable have a moderate positive correlation with teachers 'Beliefs about ICT', and with the year of participation. In addition, the 'Beliefs about ICT' uncover a moderate and significant positive variation with year of participation.

Table 4. Regression analysis to predict the change in 'Beliefs about ICT'.

	Year Beta (standardized)	Use of ICT in teaching Beta (standardized)
Teacher beliefs about ICT	0.18[a]	0.19[a]

[a]Significant at the 0.001 level (2-tailed).

Regression analyses are shown in Table 4. Beliefs is increasing significantly with Year, and with use. Adjusted R-square for the multiple regression model is 0.081, which tells us that only 8.1% of variation in the output variable (Use of ICT in teaching), can be explained by the two predictors in the model. When we only use 'Year' as predictor, the model explains 6.9% of the variation. Several factors outside these models seems to be of greater importance, and the variable 'Use of ICT in teaching' is in fact fluctuating somewhat over the years.

The impact of negative experiences with technology could be one such optional factor. To elaborate further on this, an item about cyberbullying was included in Monitor 2016: "Have you experienced harassment and/or bullying from students/former students on Internet?"

Using data from 2016, we investigate to which extent being exposed to bullying or harassment affects teachers' beliefs. Table 5 shows that online bullying is low or moderately correlated with the three items included in the belief variable. Hence, in a possible causal model the impact of cyberbullying is quite low.

Table 5. Correlation coefficients between cyberbullying and the three items contained in the variable 'Beliefs in ICT'.

	Differentiate	Motivate	Vary
Experienced bullying over Internet	−.149[a]	−.160[a]	−.243[a]

[a]Correlation is significant at the 0.01 level (2-tailed).

4 Discussion and Concluding Remarks

In 2003 there was a quite common understanding that pupils knew more about ICT than their teachers, a finding that also ITU Monitor 2003 reveals. However, the distinction between leisure and academic use was not made and it seems fair to think that in 2003 one viewed ICT use as a more purely technological skill. However, as pointed out in Hatlevik and Throndsen [11], many pupils struggle with the use of ICT in a school setting. Monitor 2016 make the same conclusion. Researchers' perspectives of children's ICT use have changes and become quite more nuanced. A substantial research effort is being made to explore how schools can capitalize on children out-of-school ICT skills, but it remains to be seen how these two clearly different worlds will complement each other in the future. The fact that about half of the teachers in 2003 fully or partially agree that pupils know more about technology than themselves can probably be seen in context with the fact that also about half of the teachers feel that technology has little to offer in schools. Norwegian schools followed in 2003 a curriculum from 1997, which emphasized the use of technology only to a minor degree. It would perhaps be expected that teachers in 2003 also would hold rather negative attitudes towards technology and that their beliefs about how technology can improve teaching were not too positive, but this seems not to be the case. 82% of the teachers in 2003 fully or partially agree that the use of ICT might make the teaching more motivating, and also the questions about if technology can improve differentiation and variation are supported to a fairly high degree.

While teachers' beliefs about technology in teaching were quite positive in 2003–05, even with a slight rise on belief measures between these years, a marked shift is seen between 2005 and 2007. Indeed, most of the change in teacher beliefs about how ICT can improve teaching in terms of differentiation and variation seem to occur during these two years (about 21% increase on the variation variable and about 29% increase on the differentiation variable). The variable measuring motivation was not included in 2007, but from Table 1 it is clear that the levels were already very high on this variable in 2003 and that increases are small to moderate. One interpretation is that while teachers in 2003 were motivated they did not fully see the pedagogical potential. As the use of technology mature and confidence rise, it is likely that the beliefs about the benefits that technology could offer would rise. National strategies are also important factors in this context. In 2004 Norway launched a third national strategy to improve the use of ICT. Different from the prior two (1996–99 and 2000–03) the new strategy "Programme for Digital Competence 2004–08" [15] was much more all-encompassing and targeted infrastructure, learning resources and pedagogical use, skills and competence, and research and development. However, the curricula reform "The Knowledge Promotion" in 2006 [16] might have played an even more important role with an emphasize on ICT as a basic skill and clearly stated aims where ICT often is mentioned specifically. Since the curriculum in Norway is mandatory, it seems likely that teachers felt obliged to alter their teaching with ICT. The combined effect of more mature use of technology in the schools, more push from national government and a curriculum that requires the use of technology could be much of the answer of why teachers became even more positive towards technology in the mid-2000s. From 2007 and on the changes in teachers' beliefs are small in terms of scores on the variables.

It is not obvious if use of technology alters teachers' perspectives about the usefulness of ICT in their teaching, or if it is the other way around where teacher beliefs are influencing the amount of use. Both directions are possible and without a strict longitudinal research design, it is difficult to assess this question. However, for the variable 'Use of ICT in teaching', we observe a significant and moderate positive correlation (0.25) with teachers 'Beliefs about ICT', and also with the year for the survey (0.21). A multiple regression model was used to assess if use of ICT (over time) predicts teachers' beliefs (over time). Although not very strong, there is a significant relationship between the amount of use (over time) and teachers' beliefs. 8.1% of the variation in the teacher belief variable is accounted for by the amount of use over time. Even though teaching is a complex task with several variables involved, it would perhaps been expected that experience with technology would impact teachers' beliefs to a larger extent.

Our study is based on self-report of teachers' beliefs about ICT in their classrooms. The classroom situation can influence the transfer of teachers' beliefs into practice, and the research literature in education points to an often-observed inconsistency between teachers' beliefs, expressed in interviews and surveys, and their actual practice in the classrooms [19]. As proposed by Speer in [19], the data collection and analysis methods may lie behind these different findings concerning the relationships between beliefs as represented in surveys, and practice. Hence, our results must be regarded with some caution.

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Knowing What, Knowing How, or Knowing Where? How Technology Challenges Concepts of Knowledge

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Abstract. When bringing innovative technology into school education it has been challenging to get full benefits from the technology. Instead of seeking new ways of teaching we tend to adapt the use of technology to traditional ways of teaching. This can relate to the fact that we lack theoretical concepts that help us rethink and revise our practices. In Norwegian curriculum we see different learning discourses represented, that makes it difficult to change our concept of knowledge. It is therefore time to look for new ways of understanding the concept of knowledge, to be able to build new perspective on learning and teaching that opens for a more innovate way of using technology in education. George Siemens' connectivism gives interesting contributions to this transformative process, and may inspire to new concepts of knowledge.

Keywords: Knowledge paradigms · Didactics · Technology in education · George Siemens · Connectivism · Knowledge-flowing circles · Knowledge networks

1 Introduction. How Do New Technologies Challenges the Concepts of Knowledge?

The Norwegian national curriculum has recently been revised and in the preparation of the new curriculum from 2020, it has been pointed at the necessity of defining new perspectives on using technology. However, it can seem that the concept of knowledge in the curriculum is not adapting the new possibilities that innovative technologies bring to education.

The paper will present some challenges about how we understand knowledge today and argue that we need a new concept of knowledge that can capture the benefits of using innovative technology in future education. The paper is based on a theoretical investigation connected with a larger study that aims to answer questions about how students work and learning change when they use innovative technology in compulsory school in Norway, where questioning the concept of knowledge in school has been an important part of the study's theoretical investigation.

To understand education in light of innovative technologies it is necessary to see how new technologies challenge the concepts of knowledge itself. The way we

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 616–624, 2019.
https://doi.org/10.1007/978-3-030-35343-8_65

understand knowledge and knowing will guide how we teach and understand students' learning in all pedagogical institutions. This paper will briefly present some challenges in the concept of knowledge, based on the Norwegian experience and present some perspectives on how the concept of knowledge must change in light of innovative technology and learning.

The research question for this part of the study has been: How do new technologies challenge the concept of knowledge, in order to discuss the need of revising what we understand by knowledge when using innovative technologies in school.

2 Method

The study is part of a larger case study of how students use technologies at school. This part of the study is a document and literature review where the main objective is to discover the meaning of knowledge in Norwegian curriculum, to be able to discuss the necessity to develop a concept of knowledge that captures the changes that innovative technology brings to education. I have mostly based the review on strategy documents and curricular research in Norway as well as some general aspects on didactics and knowledge.

3 Results

It is no exaggeration that the technological revolution has transformed our society. In short time our everyday lives have undergone substantial changes. Keywords are cellphone, pads, computers, internet social media a.s.o. In Norway, already in 2008, 99% of students in compulsory school had access to internet at home [10]. They use more advanced technology outside school than in school, and participate in different social networks [11, 12], which give them competences that can be of use in school work. They have access to technology that able them to mediate not only learnt material but also expressions of their own unique experiences. And they have the possibility to influence the learning activities in school, by the potential to control their own construction of knowledge, the way they seek new knowledge and understanding, and to control the tools they use to create learning conditions [13]. This raises several questions about the concept of knowledge in school. Can we capture the transformations within a traditional perspective on knowledge or do we need new concepts to get new understandings?

3.1 School Knowledge as a Persistent Traditional Concept

Gavriel Salomon point at all the possibilities that technology bring to education that is not exploited because the school keep to a traditional way of understanding learning and teaching [14]. Digital tools work well for drilling basic skills, and a lot of such tools are developed within the behaviourist tradition.

The increasing use of innovative technology in our society bring forward the need of questioning the core concepts of knowledge and learning in school. But the traditional concepts of school knowledge can be very resistant. Swedish Gunilla Svingby formed some very important questions about school knowledge already in the 1980s [4]. She did a short knowledge test of 9 questions from typical school knowledge, on a group of 100 Swedish school leaders. None of them were able to give correct answers to more than half of the questions, and 60% had only 0–2 correct answers [4]. In other words, none of the school leaders were able to master a typical test that were used to test and grade students' learning outcome. Svingby meant that this showed that the belief in school knowledge as a measurable size was exaggerated, and that most knowledge that e.g. teachers have about their subjects are achieved after leaving school [4]. Even if this was more than 40 years ago it is an ongoing discussion about what school knowledge should be, and of the need to measure learning outcome as detailed as possible to control students' learning outcome. The concept of school knowledge seems to be situated in a long tradition which is hard to change.

3.2 The Norwegian Curriculum and Didactic Traditions

The Norwegian compulsory school (13 years, from the age of 6 to 19) build upon a European critical-constructive didactic tradition [1], which is concerned about how education contribute to the upbringing of autonomous, independent and responsible individuals to participate in a future democratic society. This tradition is founded in the German didactic tradition which has had great impact on Norwegian Education through centuries. The critical-constructive didactics is influenced by Wolfgang Klafki, who tried to integrate two theoretical perspectives on "bildung"[1]; material bildung and formal bildung into one [1]. The material bildung-theories hold the content as the key to bildung through transferring the cultural heritage to students. The formal bildung-theories were mostly concerned about how the selected content contributed to developing cognitive skills, problem solving and critical thinking, a.s.o. Klafki meant that bildung must be understood not only from a content perspective but also had to consider the impact of the social and cultural context of education. In his critical constructive didactics, the critical element is connected to a continuously, critical investigation of the school curriculum, content, methods, assessments and so on, as well as the schools' role in a broader society context. The constructive element is about the school's responsibility for the general challenges of the society like fostering values like self-determination, solidarity and participation [1].

Britt Ulstrup Engelsen took part in an evaluation of the present Norwegian national curriculum [19] in 2008 [5]. She analyzed knowledge discourses represented in the curriculum, and found that there were different present. The core curriculum, which states some basic principles for Norwegian Education, represents two competing discourses; one concerned with the individual and one that is more social oriented. She found that the core curriculum states that learning is an individual matter but also involves the social situation in which learning takes place [5]. She also finds that the

[1] The German concept of Bildung has no English word but the concept states that education is more than the simple acquisition of knowledge and skills. It has to do with nurturing the students, to develop their individuality, subjectivity, independence, or just "becoming and being somebody." [2]

subjects in the curriculum is much oriented towards learning content, even if they have exchanged «knowledge» with «competence». She argues that «competence» can be synonymous with knowledge, skills and attitudes [5] which is similar to the way the concept of knowledge was used in previous curricula. Engelsen [5] shows that there are two strong traditions in Norwegian school, a socio-constructivist perspective in the core curriculum and a behaviourist perspective which shows through the strong emphasize on basic skills [5]. Participating in the PISA-program and other international tests also have contributed to strengthen the behaviouristic traditions because the tests only measure basic skills, not complex competences like problem solving [6].

Hodgson, Rønning and Tomlinson conducted a study to evaluate the connection between teaching and learning, emphasizing on the teachers arguments and practice based on the curriculum, finding a tendency towards being instrumental as strongly evident in our present curriculum from 2006 [3]. Our education is occupied by the need of valuating students' learning and outcome using specific measurable criteria.

The same researchers therefore are concerned that in the eagerness to document measurable learning goals, the main goal of education: knowledge, skills and attitudes that our future generations need to participate in society, will be neglected. This indicates that a behaviouristic learning paradigm has a strong position in the curriculum even within a critical constructive didactics. It seems that the concept of knowledge is influenced by different traditions, which can increase the challenges of changing how we perceive knowledge as phenomenon.

3.3 The Development of a National Strategy for Digitalization in Education

In all Norwegian strategies for digitalizations since the first strategy in 1996 to the present strategy from 2017 [7], the focus on how technology has changed our society. To meet the future's challenges students in school need to learn to handle and live with the possibilities and challenges that a more and more digitalized society brings. Communication, knowledge- and information sharing, and the premises to take part in working life and society, change due to the digital and technological development [7]. In the strategies developing 21. century skills have been important. This is e.g. subject specific competences, collaborative skills, critical thinking ethical evaluation skills, citizenship, problem solving, and meta learning skills (learning to learn).

In the national curriculum from 2006 [19], using digital technology first was implemented as a basic skill in all subjects, together with reading, writing, calculating and oral skills. In 2010 a framework for basic skills were added to the curriculum to help teachers define the content of the basic skills. This framework has been revised a couple of times, last in 2017. It states that:

Digital skills involve being able to use digital tools, media and resources efficiently and responsibly, to solve practical tasks, find and process information, design digital products and communicate content. Digital skills also include developing digital judgement by acquiring knowledge and good strategies for the use of the Internet. Digital skills are a prerequisite for further learning and for active participation in working life and a society in constant change. The development in digital technology has changed many of the conditions for reading, writing and oral forms of expression.

Consequently, using digital skills is a natural part of learning both in and across subjects, and their use provides possibilities for acquiring and applying new learning strategies while at the same time requiring new and increased powers of judgment [16].

The framework of the basic skills is a trial to describe how digital skills can benefit students' learning in school. However, the framework does not explicitly say anything clear about a future concept of knowledge.

4 The Need of an Alternative Concept of Knowledge. Discussion

Danish Lars Qvortrup says that the society can be perceived as a hyper complex social system where a lot of different systems influence each other. Qvortrup mentions systems as "the political system", "the educational", "the ethical", "the religious", "the economical" and so on, and says that all these systems have their own mindset that forms the way they understand all the other systems, one by one or as a whole unity [9]. The hyper complex society is related to our modern times. Previous times have hardly had the complexity we see today. This also impacts the educational system which has to adapt to the changes that occurred in the transfer from industrial to knowledge society. But Qvartrup also point that even if we mention knowledge as the foundation of today's society it is not obvious what knowledge is or in what categories knowledge can be differentiated into [9]. This exemplifies the difficulties connected to establish a concept of knowledge that works within the perspective of innovative technology.

As stated above it is possible to define at least two different learning traditions and two ways of representing knowledge in the national curriculum; the behaviorist and the socio constructivist [5]. However, it is a question if these perspectives are sufficient for understanding how technology transform education and society. And how this will implicate a new understanding of the concept of knowledge. Innovative technology goes beyond all borders, also geographical, and knowledge and learning must therefore be understood in a global and intercultural perspective rather than situated in a specific cultural context, like the socio-cultural paradigm presupposes. These perspectives are problematic to place within the knowledge discourses represented in the Norwegian curriculum. And it can make problems with exploring both benefits and challenges with technology in educational use.

4.1 George Siemens' Connectivism and Knowledge

One of the contributions to develop a new understanding of what knowledge may be in the future, is Georg Siemens. He launches the theory of connectivism as an alternative to the traditional learning theories. Inspired of different theoretical perspectives like network theory, chaos theory and new trends in understanding learning, he says that learning takes place both at an individual level and at an organizational level, and that learning is a continuous process that is mainly informal and not formalized in an educational institution [8].

Siemens [8] argues that knowledge no longer can be understood as a static phenomenon since knowledge is continuously changing. It is not possible to establish a common and universal agreement of what is knowledge anymore. He argues that both behaviourism, cognitivism and constructivism limits the way we perceive knowledge when using technology because none of these perspectives are open to include all the possibilities that new technology provides for learning and knowledge development. Behaviourism define knowledge as change of behavior, and learning as a phenomenon that cannot be observed directly but shown through stimuli and response. Cognitivism define knowledge as symbolic, cognitive constructions and learning as a question of mental processes where sensing, coding, storing and retrieving information are essential. In a constructivist perspective the learners create knowledge by finding meaning in their experiences. All three perspectives share the concepts of learning and knowledge as something going on inside the learner, not outside, like stored in a computer or distributed in a social network [8]. Siemens writes:

Many important questions are raised when established learning theories are seen through technology. The natural attempt of theorists is to continue to revise and evolve theories as conditions change. At some point, however, the underlying conditions have altered so significantly, that further modification is no longer sensible. An entirely new approach is needed [8].

Siemens says that existing learning theories are occupied with the learning process itself and not with the value of learning something. To decide the worth of learning something is a meta skill that occurs before the learning itself has started [8]. This gives meaning in today's situation when we have access to a never-ending source of information. It is no longer possible to overlook what we can call relevant knowledge or what is possible to learn within a specific field. A concept of knowledge with the limitation of what can be stored and retrieved from an inner storage will not be able to capture what learning and knowledge is. We need a wider understanding of the concept of knowledge to be able to handle matters of learning and knowing when using technology that also considers the process of selecting what is worth learning. When it is no longer possible to learn "everything" it will be crucial to have skills that able learners to select what is worth to know and what is not. Or else learning will be a far too time consuming exercise.

Siemens views knowledge as a flowing circle, a model where knowledge flow through different stages where it is created and formed [15]. The model builds on that individuals, groups or organizations create knowledge in different ways, and that the knowledge circle contributes to refining, changing and further developing it. The different stages in the knowledge circle is "co-creation, dissemination, communication of key ideas, personalization, and implementation" [15]. The stages show different ways that knowledge processes through this flowing circle. With co-creation the ideas meet other ideas which integrates and takes new forms as they are elaborated by other participants in a network. The ability to build new ideas on the base of others thoughts and work, is important [15]. Lots of new knowledge today generates this way, through social media in knowledge networks that can develop knowledge about specific issues that hold high quality, for instance Wikipedia, which is a participant driven encyclopedia that today is viewed as an accurate and relevant source of information. Dissemination means the way knowledge is refined in networks through critical analyzes and reviews. All information is not «good» knowledge but dissemination filters and sort out and validates the knowledge that gives meaning within the specific network and context it is meant for [15].

Communication of key ideas is the stage that follows co-creation and dissemination, and sends the key ideas that are worth spreading wider through different networks [15]. At this stage of the refining process the ideas are ready to be tried out to see if they are meaningful in a wider perspective. The last stage, personalization, means an internalization of the knowledge to those who need it, a process that both involves reflection and discussions with others [15]. At this stage, new knowledge integrates with existing knowledge at an individual level. Finally, the knowledge reaches the stage of implementation when the individual acts in line with the new understanding [15]. New knowledge contributes to enlarge, strengthen or change existing knowledge constructions. Next, it will take new forms and go back into the knowledge flowing circle where it will be transformed and used in new situations and contexts.

With Siemens' contribution we see a new concept of knowledge taking form. Where knowledge construction earlier has been dependent of reliable and stabile sources like books and articles, we now see it as a flexible and rapidly changing phenomenon that takes new forms as it floats around in networks, being adapted by individuals, groups and organizations through continuous learning processes. The question of how we validate knowledge must be rethought. We are used to rely on experts and authorities to valid knowledge but in Siemens' model, the information flow in itself contributes to validating knowledge through the different stages in the circle. This also involves that the traditional sources no longer can have «ownership» to knowledge because it creates through continuous social processes. In this perspective the concept of knowledge must be redefined from a fixed and controllable size to a flexible and rapid changing phenomenon that is being created and recreated continuously.

When implementing innovative technology in school it is necessary to develop new concept of knowledge in school. Like Salomon states, it is impossible to gain full benefit from technology if the frame we put technology into is the same as we put the traditional teacher in [14]. It is not an easy task, but Georg Siemens' connectivism can be an inspiration to find new ways to understand knowledge.

4.2 The Limitation of Connectivism Theory and the Concept of Knowledge

The concept of knowledge that is presented by connectivism can only work in general educational purposes in school, like primary school and lower secondary school. Connectivism cannot be universal for all subjects and specifically not for higher education where the learners certainly need a base of knowledge that is internalized to develop profession oriented competences. This cannot be reduced to the knowledge that develop in Siemens' floating knowledge circles but has to be part of the profession competence that the student develops through their study [17]. Criticists also state that connectivism is not possible to describe as a theory of learning because it does not build on existing theories, especially on actor-network theory and activity theory in learning where the role of networks and artefacts are explored and explained [18]. Still it is a possibility to be inspired of connectivism to expand the concept of knowledge to something that is different from the traditional way view of school knowledge.

Bell [18] refers to Verhagen when suggesting that connectivism can be placed at the level of curriculum where it can help develop new pedagogies that puts the learner in control of the learning process. I support this idea because it captures some important issues about learning and knowledge in the future: “Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision” [18].

5 Conclusion

Learning in the future will not be the same as it is at the present. Technology brings in possibilities that brings forward the need to change our concept of knowledge. When it is no longer any «correct» knowledge, the ability to judge information, to argue for ideas, to validate knowledge in new ways, will be important skills to develop in school, to assure that students’ don’t build their knowledge creations on misconceptions and non-qualified facts.

George Siemens’ connectivism cannot be regarded as a new theory of learning but it can be used as a model for inspiration when understanding what knowledge will look like in the future. Therefor it can be used to understand learning and knowledge in light of innovative technology. When knowledge is created along its way through the knowledge flowing circle, its sustainability depends on the response it meets along the way. The social collaboration in the network is central for this creative process. Learning must then be understood as active participation in networks where knowledge flow. In school this means that we need to focus on other learning strategies than remembering content. The ability to critical thinking and source critics will be crucial for students’ learning outcome, and social skills that able students to participate, discuss and communicate, will be of most importance.

Technology have changed the way we learn because a lot of the processes that earlier had to be handled by the individual, now can be distributed to or supported to technology. This increases the cognitive capacity, both in individuals and organizations, making more complex and demanding learning processes possible. Learning turns to be more than “knowing what or knowing how”. It also concerns “knowing where” to find relevant knowledge when needed [8].

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Online Course and Web-Based Environment

A Data Visualization for Helping Students Decide Which General Education Courses to Enroll: Case of Chulalongkorn University

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Abstract. Chulalongkorn University has been utilizing information systems for course administration system, named CU-CAS, to help manage the course syllabus, course contents and course satisfaction survey. While current students have been selecting courses based on information from seniors and friends, we recognize that the data from CU-CAS could be useful in selecting course, but have not been fully utilized. Therefore, this project aims to design a data dashboard to help students select courses to register, based on the data from course satisfaction survey by students from the past three years of course offerings. In this work, we developed CU-CAS data visualization using Google Data Studio. Data were analyzed and presented the overall of the evaluation result in term of dashboard. According to our pilot study, students make decisions for enrollment by comparing the evaluation result in the past three years, in the form of different indicators. We also collected and analyzed data from the student blogs that review courses that they took using word cloud and Markov chain. Both data from CU-CAS and blogs will be represented to students to help students make decision in registering courses. This project is one of the e orts to utilize data in a way that is easy to understand to students, allow Chulalongkorn University to understand students learning behavior, and bring back to plan and adjust teaching strategies.

Keywords: Data analysis · Data visualization · General education · Markov chain

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 627–635, 2019.
https://doi.org/10.1007/978-3-030-35343-8_66

1 Introduction

Nowadays, the world and society are changing rapidly and continuously. The situation increases the importance of effective uses of data, as we can see from many organizations that started analyzing their data using data science, data mining, data visualization or statistics for the benefit for the organization.

To create and manage curriculum data, Chulalongkorn University has created "Chulalongkorn University, Course Administration System" (CU-CAS) [12], which helps instructors to create course syllabus and evaluate student's learning efficiency online. This large amount of data has not been analyzed, processed or visualized in the form that is easy to understand to find the relations and trends of data. We see the potential of using such data to help us understand student's learning behaviors, plan and improve curriculum and help student to make a decision for course enrollment. So we take these data to analyze with statistic and use Google Data Studio [3] to make data visualization in the form of a dashboard to help students select courses to enroll.

Chulalongkorn University requires students to enroll in general education courses, which are courses offered by all departments to increase the breadth of skills for students. The general goal is to emphasize the learning of social responsibility, thinking process, and to allow students from different departments to take classes together. There are 6 classifications: Humanities, Science-Math, Interdisciplinary, Social Science, Foreign Language and 21st Centuries. The number of available courses is 384. While in-major courses are offered to students in the department, general education courses are offered to students from all departments in the university. Therefore, selecting a course is a challenging task for students, due to the breadth of available courses. Students normally ask for advices and information from friends and seniors who took the courses before in order to make decisions about which courses to enroll.

In this work, we collect the online course evaluation data that was collected in CU-CAS, which is in the form of numbers, on a scale of 1–10, according to various indicators, which is evaluated by the students. They had not seen the results yet and they want to know the overview of the courses that they evaluated. Therefore, the data were analyzed by statistical methods by using a weighted average. Then the results are displayed as a data dashboard using Google Data Studio. The dashboard was designed to help students select general education courses by comparing three courses. The reason that the course comparison was designed to compare among three courses was because we did a preliminary study and students normally select general education courses by comparing three courses to choose two. The university does not allowed enrolling in more than two general education courses.

In addition, we have collected course reviews from several websites to see the overview what most people talk about the course, what are the significant keywords. By word splitting and count the frequency of the words and find the association of words, Markov Chain. For further information in comparison courses in a format of word cloud (Fig. 1).

From research, we found that dashboard has helped users to plan enrollment and compare course assessment with past 3 years data with different indicators. The

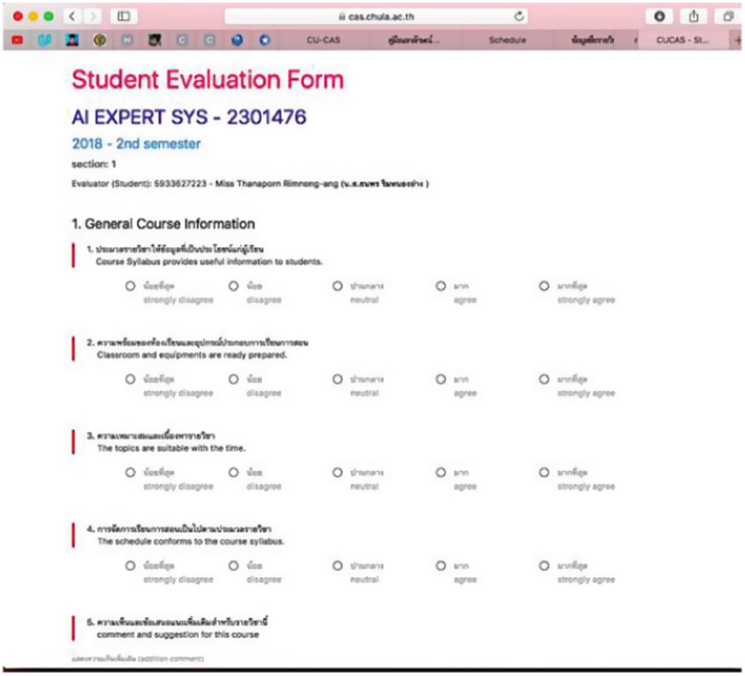

Fig. 1. Example of CU-CAS evaluation form (2301476 course, accessed: 2019-05-26).

instructor can use data from dashboard to improve curriculum in future. Providing more ways to visualize data will also provide more benefit for users.

2 Background and Related Work

2.1 Course Review System: CU-CAS

CU-CAS is a learning evaluation online of Chulalongkorn University that evaluated by students every semester. Which has four indicators. First, how much useful knowledge do students get from the course? Second, how much do students practice critical thinking and creative thinking from the course? Third, how much do students practice communication, presentation and use information technology from the course. Each indicator was rated as 1–10. CU-CAS stored in an Excel format and never analyzes in students' ratings of their teachers and responds the result to them.

2.2 Course Review Blog

The courses review that collected from websites is a commentary from students who have registered from the course. These help students who are interested to enroll in the course making decision before enroll. The addresses are followed:

1. http://genedxpaysus.blogspot.com
2. https://sites.google.com/site/medicgenedsuggestion/information
3. https://sites.google.com/site/dentcusubjectinfo/
4. http://vichakarnartscu.blogspot.com
5. https://polscireview.wordpress.com
6. https://genedforecon.wordpress.com

2.3 Related Research

In this section, we will discuss about the related research that can be useful for education visualization summary.

Robert et al. has survey his Fifty-three students by using The Five Design Sheet Methodology (FDS), a five steps of brainstorm features and found that, describing a method using visualization help students mapping ideas and following learning content immediately [8].

Shi et al. collected video clickstream data from MOOC (Massive Open Online Courses) to analyze student learning performance and evaluate the courses. Shi et al. got users first impression by visualize the overall statistics provide user using a demographic. To help students develop learning engagement [10, 11].

Vimolboon and Phasit have utilized the online evaluation of the hotel in Chiang Mai from customers by using word cloud to summarize the feedback. Therefore, the hotel can adjust the strategies from the article results [2].

Beatriz and Aimee used word cloud with an online course. They said that Using word cloud gets the better results because we can see the importance keywords easier than reading article and it causes the critical thinking [7].

Tianshu, Yuefei and Changjiang wanted to get more information about the movies for the audiences to know more details. They applied word cloud to see more the details of movies based on the viewers' comments from blogs [4].

Bhumika and her colleagues collected reviews from online shopping websites and visualized the information in term of word cloud to show that reviews are in positive or negative way [5].

Seet and Hong let participants fill out online questionnaire in the open end questions in their own word. Then the word count and meaning are extracted. The authors found out that the opinions that is in the word cloud would help changing the participants' perception [9].

Toasa and Maximiano studied on the available techniques of data visualization for real-time information and review about the most popular data visualization and identified a set of distinct Data Visualization techniques [6].

Gupta and her colleagues applied Statistical multivariate and univariate general linear models to determine the relevant results and graphs to analyze the difference in students' ratings of their teachers in five departments. They studied the effects of gender and socio-economic diversity [1].

Our related researches have shown that visualization word cloud is the way to display information in both positive and negative which provide more information and to help student selecting the courses for enrollment.

3 Methodology

3.1 Data Collection

We collected data that assess general education courses from two sources: CU-CAS course rating data and blog reviews.

CU-CAS Results. We collected the CU-CAS data in past three years and converted into a table in Microsoft Excel format. We then calculated the KPI values by using weighted average method. The average KPI values are shown by using Google Data Studio in three separate columns. Each column shows the average value of each KPI, so that students can compare the courses information easier.

Blog Data. We collected 1,183 reviews data of 157 courses from six blog websites. They review general education courses using casual/in trend vocabularies and phrases, which attracted many young students. Many keywords they use are the information that students are looking for, such as, “easy”, “good grade”, and “homework”.

3.2 Data Pre-processing

CU-CAS

- *Data Integration*: Import data files into separate files, which is term that aggregates to the same file using Tableau Prep.
- *Data Transformation*: Mapping the course name and course classification and add academic year column and semesters column in file.

Review

- *Data Integration*: Collect reviews with course. Reviews are collect from 6 websites that student commonly used. Which each website come from student’s interview.
- *Data Cleaning*: We remove name or no meaning word and symbol.
- *Data Transformation*: We collect data in form of Course and review.

3.3 Data Processing

For CU-CAS data, we take the data that have been pre-processed to compute weighted average which results in average of all the KPIs. Then we take the result to represent in Google Data Studio. For the review data from Blog, we first perform word segmentation, where a paragraph of input text is segmented into words. Then, the frequency of words are computed for all the words found in the reviews. The results are represented in form of word cloud. Moreover after segmented word we compute Markov chain of the words to find relationships among them. The framework is shown in Fig. 2.

3.4 Text Summarization Using Word Cloud

For word cloud process, first we collect reviews from websites that we mentioned before in Microsoft Excel then we segmentation reviews to find word frequency with programming and we take data to do word cloud visualization with Tableau. Word

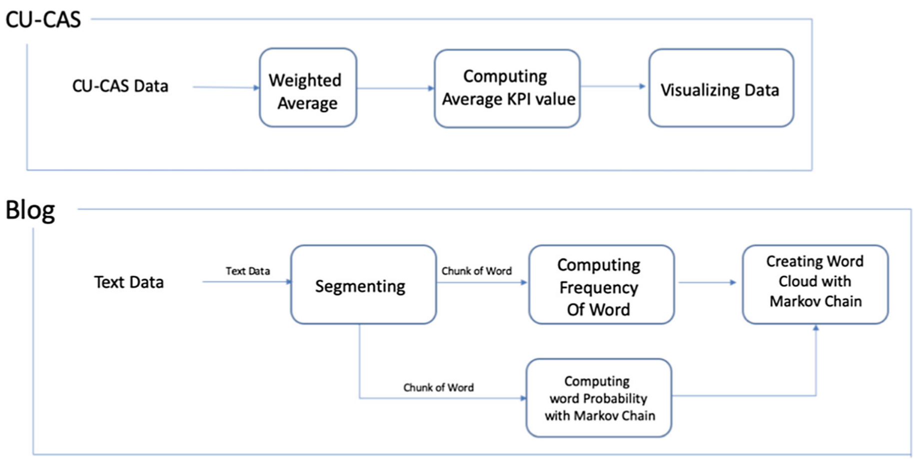

Fig. 2. Data processing framework.

cloud process could help student to seen overall course instructional and opinion to help student make decision to enroll course easier.

3.5 Markov Chain of Word

We will process segmented reviews with Markov Model to shown probability how word sequence should be and Overall review should be positive or negative.

4 Result

4.1 Statistic of Data

We collect instructional assessment from CU-CAS consist of subjects which data is from last three years that evaluated by students who enrolled in each subject. Evaluation has four indicators, each indicator score from 1 to 10. Then we take these score to compute average satisfaction which overall stratifications score of all course in the university is 6.93. In part of reviews we collect from blogs consist of 157 subjects and 1,183 reviews.

4.2 Course Comparison Dashboard Using Google Data Studio

There are three parts in dashboard. Top left shows the average evaluation score of all faculty in Chulalongkorn University. Top right shows KPI trend in the past three years. And the bottom shows three courses comparison where each column in dashboard represent one subject. Each column consist of average score of each indicator and total average score for comparison

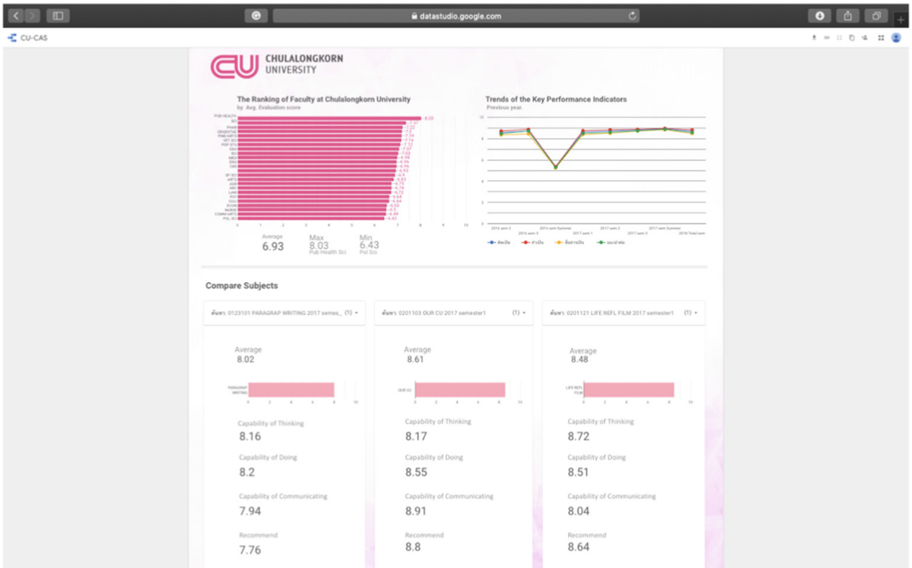

Fig. 3. Comparing score of course 0123101, 0201103, 0201121 respectively.

4.3 Blog Summarization with Word Cloud and Markov Chain

In Fig. 4, we represent with a result of word cloud and Markov chain using convenience sampling method. Word cloud size and color represent frequency of word. The larger and darker color represents more important detail than the smaller and lighter color one.

Fig. 4. Word cloud summarization with Markov chain by convenience sampling method from course 0123101, 0201103, 0201121 respectively. (Color figure online)

Thai	English
ดี	Good
ไม่ยาก	Not Difficult
ง่าย	Easy
แนะนำ	Recommend

Fig. 5. Vocabulary translation from Thai language to English language.

4.4 Discussion

From Fig. 3, score to assess course satisfaction alongside Fig. 4, shows the frequency of words found in the text of the review that course. The size of the text and colors are represented shown by the frequency of the word. If the text is large and dark, it is very common. It can be seen that the keywords and the scores show similar trends. We can see that among the three courses, course 0201103 has the largest word cloud, where the meaning of the words is shown in Fig. 5. In Fig. 3, the course with the highest average overall score between three courses is 0201103. The second highest is 0201121 where, in Fig. 4, the size of word cloud is also second largest. We can see that using of both visualization of CU-CAS and word cloud with Markov chain represent information that helping students to make a decision toward General Education courses. From queried the users found that this dashboard is helped to make a decision for enroll courses and the reason is they can see an overview of the course easier. Both of the evaluation score and size of keywords in word cloud according to the frequency found in the course of that review.

5 Conclusion

In this paper, we developed the data visualization to help students decide to register general education courses. We collected data from course satisfaction survey in the past three years is represented by Google data studio. We also collected the courses review from blogs and websites, we then segmented and calculated frequency and the relationship of words using Markov chain. Both data visualizations by google data studio and by word cloud enhance students experience in receiving past evaluation information about the course that they intend to register in the future. It is interesting to explore how given information help students in planning to register course in the future.

Acknowledgement. This research was supported by the Learning Innovation Center (LIC), Chulalongkorn University.

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Experiences of the Flipped Classroom Method —Does It Make Students More Motivated?

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Abstract. The aim of this paper is to highlight use of the flipped classroom method, and how teachers perceive this teaching practice. More specific the research focus on whether the teachers' experience that the model leads to increased motivation in the students learning process. The background for the research is generated from qualitative interviews with teachers, and the empirical data obtained is from semi-structured interviews with these informants. The results show that the flipped classroom method in fact did increase participation and cooperation, which in turn generated motivation and willing students. The teachers got more time for guidance of each student, which provided more solid knowledge on each student's academic level.

Keywords: Flipped classroom · Video · Learning processes · Teaching strategy · Communication

1 Introduction

This paper aims to explore in which way teachers' experience that use of the flipped classroom method motivates students. The flipped classroom is gaining acceptance in higher education as an alternative to more traditional methods of teaching, and can be defined as: An educational technique that consist of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom [1]. Research [1–4], claim that students are positive to the method, and teachers reported that the learning situation in the classroom became more active [2, 3]. More time available for the teacher in the classroom is the main goal of flipped classroom in the learning situation. However, does the flipped classroom contribute to increased motivation among the students at the University? Motivation is a precondition for learning, and motivated students learn better at school [5, 6]. Learning outcome relates to learning strategies. Based on that, this paper analyzes whether teachers feel that the flipped classroom reinforced the students´ motivation so that their interest in further learning is stimulated. Many study plans state that the best learning outcome is achieved when students take an active part in the different forms of learning through the study. The teachers learning strategy affects their use of learning methods in the classroom. The study has the following research question: *Did teachers experience extended motivation from students by using the flipped classroom method?*

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 636–643, 2019.
https://doi.org/10.1007/978-3-030-35343-8_67

2 Theoretical Frame

Flipped classroom is also known as inverted classroom or flipped learning [7–10]. The aim using flipped classroom is to make video available outside the classroom for the students, as a preparation for subsequent teaching session. This emphasizes time for discussion, group work, guidance, task-working etc. in the classroom [10]. Research shows that teachers find good learning outcome by the students when using video as a learning resource and use the classroom to provide guidance [11]. However, the flipped classroom method demands for substantial resources [9, 11].

Learning theories are abstract frameworks that describe how knowledge during the learning experience is receive and processed. Different learning theories can be linked to the flipped classroom. The overall goal in school is learning. Learning is a complex activity and there are various approaches to this. Within the pedagogy, there are different theories: behaviorism, cognitivism, constructivism and socio-culturalism. These theories follow a timeline starting from behaviorism, which was the dominant learning view in the early 1900s, to a socio-cultural view of learning today. Behaviorism is associated with experiments with rats and dogs (Skinner and Pavlov). Behavioral learning vision describes knowledge as objective and quantitative [12]. Knowledge exists outside the individual. Learning is a change in behavior in that the individual responds to various stimuli. In other words, learning can be observed. In order for the learner to be able to learn, the knowledge is divided into sequences. Learning is carried out by the learner accumulating small pieces of knowledge step by step [12]. This was a dominant learning vision in the early 1900s. Behaviorism is described as the theoretical basis for traditional teaching and curriculum building in most countries where students initially learn basic facts and only at a later stage do they expect them to be able to think, reflect and use what they learn [13].

Cognitivism sees the human being as fundamentally curious. This leads to a desire to gain more knowledge and put it into system and context (Piaget). The key is how a person receives and processes information, and then puts it into his or her experiences and mindset, possibly changing his or her experiences and mindset. Cognitivism views a person as an active participant in his or her own learning, where knowledge is transferred, stored and processed.

Constructivism is based on theories of what knowledge is (John Dewey[1]). Knowledge becomes a tool for action based on each person's thoughts, own experiences and are therefore important. Students construct their own knowledge based on their own experience. Teachers and students work together to process the students' knowledge so they can develop an adequate understanding of concepts and subject-related knowledge [12, 13].

Socio-culturalism is based on theories (Vygotsky), and the learning view emphasizes that all learning takes place in a social context, a person cannot learn in a vacuum. The language is very central in all learning processes. Learning and knowledge for all humans is related in the context of culture, language and community. Learning takes place through an interaction between people and tools/artifacts in a cultural and

[1] https://no.wikipedia.org/wiki/John_Dewey.

historical context. This interaction causes people to change as individuals: both intellectual and linguistic/communicative, and the way of handling physical tools. Learning is basic social, happens everywhere and all the time, and especially when you are a part of a community. Learning is social because knowledge is distributed, and implies that different people can do different things.

3 The Case

The case is a study of a 15-credit course for 23 students in their 2nd year of the bachelor's degree at the social worker education at a Norwegian higher education institution, during the fall semester of 2018. Three teachers were involved. All of the information about the course; the organization of the flipped classroom as well as the program for the students, was posted in the learning platform Canvas prior to the semester start. The organization of the course was as followed: each week, a short video lecture was published. This lecture was published with different file formats for use on PC, Pad and Mobile. In addition, an audio file was posted. For the lecture, notes and/or foils that were central to the video lecture were published. For each video lecture, an individual assignment/task was also posted. This was to be completed and handed in at the end of the week. One individual thesis was central and could be used as a basis for both work requirements and exams. The students were encouraged to work on this every week, and used groups to discuss topics before the assignments were completed. The mandatory individual assignment was given at the start of the course and had to be delivered before the exam. Every Wednesday, time was set for guidance, - both for the individual assignment and for the group work requirement. Prior to the guidance, the students were to submit an e-mail with the theme that the student or the group requested feedback on. The teaching was done in both Norwegian and English. The students further, both in writing and orally, pointed out that this was a labor-intensive subject, which required a large degree of self-activity. By organizing the subject in this way, the teachers wanted to give more time for guidance, as learning is independent of time and place. Video lectures were intended as a brief introduction to various topics, and was always available for the students for repetition. As students, they had to study the curriculum and theme more thoroughly. It would therefore be easier for each of the students to organize their own learning at their own pace. The assignments supported the learning objectives in the course. For the teachers, the flipped classroom method would give them a good opportunity to be more active in the forefront of each student's learning process. In addition, this would give them the opportunity to evaluate the students' prior knowledge, and therefore be able to prepare more individual assignments for each lecture. The students were encouraged to make contact if they had questions or for other reasons wanted this.

4 Methodology

This study on the flipped classroom method follows the hermeneutic and qualitative tradition in pedagogical and social work research [14, 15]. Qualitative method is characterized by direct contact between the researcher (teacher) and those studied (the students) [16, 17]. The empirical data was collected in the form of interviews with three female teachers. The data collection followed the progress of the flipped classroom study, the semester start in autumn 2018. Interview as a method provided rich and descriptive information about how the teachers experienced the flipped classroom method as a factor when making the students more motivated. The researcher collected and analyzed data, which formed the basis for the results that appeared. Flipped classroom is new in the social work study program, so the teachers were key actors and contributors to this field in their subject. The number of teachers as informants provides a limited empirical selection and challenges with generalizability. The interviews were carried out face-to-face as semi-structured interviews [18]. The teachers themselves decided the time and place (at their own workplace) for the interview, and were also given the opportunity to make inputs regarding the scope of the interview. All of the interviews were transcribed. The study also includes the analysis of significant amounts of archival data including notes and documentation related to planning and organizing the social study. The study has followed the standard related to research and ethics[2]. The methodological choices and assessments are explained to make the study reliable and accurate.

4.1 The Interviews

The learning strategy in this course for all the teachers is socio-cultural learning. The teachers all agreed that motivation is a precondition to learn. The introduction to the individual interviews had three focuses related to students' motivation: video, activity at school and guidance. The teachers pointed out that they, in the start and halfway throughout the course, specifically had told the students that they had high expectations of each students.

Video

The teachers expressed that theory presented in videos before the guidance at school, was a factor that they believed increased the social work students' motivation. They claimed that motivation made the students meet prepared for the class. One teacher said: *«Using FC makes it easier to differentiate; students get more inductive and sociocultural learning. Students can watch the video as many times as they want, pause, rewind, and repeat the material whenever they want. They can ask for guidance on exactly the substance they want. This allows them to resume teaching in the absence. At the same time, I think the method is time consuming in terms of all the time it takes to make video clips. Students have a constant access to the Internet and multiple social networks. They are even used to produce, share and publish videos themselves. I have used problem-based learning to challenge students in relation to*

[2] Norwegian Social Science Data Service (NSD).

their own "virtual communities". The use of technology supports the process of producing, sharing and accessing information and as documentation of learning. I think this way of organizing teaching led to more time at school for guidance.»

Another teacher said: *«I find that there are different kinds of motivation among students related to their ages. Those who are older clearly state that they want traditional classroom teaching, while those who are under the age of 30 want more use of digital tools. The oldest students choke on the use of flipped classroom, and I find that strange. I have been conscious to make the videos in a way that every social student can understand. I believe that when every student can understand, they can experience more motivation. I experience and that the oldest students are not motivated to receive the guidance provided. I don't know why, and when I ask for feedback they don't say anything. Through good learning and videos, the students will have the best possible conditions to acquire the curriculum, theories and practice. I think this facilitation is fundamental for social work students and every other student to be able to understand the elementary and fundamental, and to be able to practice their subject in an optimal way.»*

All three teachers agreed that use of videos prior to the classes made most of the students prepare for the guidance. One teacher said: *«My experience is that when the students come to school, they are more motivated and willing to learn.»*

Activity at School

During the interviews, the teachers were asked about the students' activity in the classroom at school. Even though the teachers had pointed out their expectations concerning each student's motivation, they experienced a variety of activity from the students at school. One teacher said: *«I am not really sure whether all of the students are more active. I experience that they generally don't read so much anymore, and I'm wondering if it is more pleasant to get theory presented in videos. We have to make the videos so interesting, that they want to read more».*

One of the other teachers said: *«As a teacher, we do know that most students learn best by being active. Of course, some students are active; they ask more questions, because they meet prepared for the class. However, it may be the time in the classroom alone doesn't help when it comes to making the students more active and motivated at all. It may be that I, as a teacher, make the whole difference by how I organize the time at school, the guidance, the tasks etc. My experience is that by telling the students what I expect from them, I actually motivate the students».*

The third teacher said: *«Some students find the activity at school as little too much work. I know, because they say so. However, some students find it comfortable that the time at school starts with the teacher talking».*

Guidance

One of the teachers pointed out that guidance was an important part of the flipped classroom, and said: *«It has happened that students say they do not understand what is being taught in the videos, and therefore cannot read the theory because it is experienced too difficult. Those students most often ask for individual guidance».*

The oldest teacher said: *«I think maybe it is more about the students coming prepared to school and therefore being more motivated. I see clearly that they both ask for* *and get closer guidance/follow-up. I think this leads to increased motivation. By this, the teaching becomes more student-centered, which in turn will give more motivation.»*

Another teacher said: *«I think it is important that the students can build knowledge themselves, and assist and interact with each other. The times I have put together groups, it has been challenging to put together groups where the students have not been on the same academic level. This is because I want the students to assist each other in using the nearest development zone. However, this requires that I know the students and the academic and social level they have, before the group work take place».*

All the three teachers experienced motivation as an important factor for learning, and pointed out flipped classroom as a factor for making more motivated students.

5 Analyzing and Discussion

Learning from a sociocultural perspective focuses on how knowledge is created and shaped by students. However, this knowledge then affects individuals and the community. Both in their learning, motivation and learning strategy, students are different. The results of the survey show both opportunities and challenges with reverse teaching. The possibilities are:

- Learning at own pace. By preparing for the class, the students can work whenever they want, whereever they want and take the time needed to complete within the given deadline.
- More in-depth knowledge of the subject. After acquiring elementary knowledge of a given subject, students can acquire more knowledge of the subject. Teachers can offer additional curriculum to those who want it.
- Better preparation. For optimal learning, students must prepare for the class. The teacher can keep up with the progress of the students and see their results. This makes it possible to have a better overview of what students experience as difficult and where they are struggling the most. It also allows the teacher to evaluate their own teaching.
- The teaching can be reused. Teachers spend a great deal of time preparing content for students' lessons. This can be reused later.
- Challenges with reverse teaching are:
- Change takes time. Implementing reverse teaching requires a lot of organization. The teacher must introduce a new concept to the students. This can take time, because one goes from a more passive learning style to a more active learning style. This also implies that the students have to be motivated.
- Develop learning techniques. Not all students have figured out which learning technique works best for them. Reverse teaching requires some self-discipline, and therefore will not be equally suitable for everyone.
- Problems with technology. Lack of online, difficulties with sound and image can make it difficult for students to learn.

The teachers concluded that the method increases the motivation of the students, since this involves much more varied teaching. There was more oral activity during the lessons, and the teachers experienced going from being a facilitator to becoming a mentor for the students. There was much more time for the students, more guidance, more adapted to the teaching according to their needs and better follow-up. Through problem solving, students were assessed on whether they had reached the learning objectives.

The teachers pointed out that they specifically had told the students that they had high expectations of each student. It is important to see that different learning theories in many ways complement and complement each other, and together provide insight into the complex phenomenon of learning [5, 6, 13]. The students studied the video before they came to class. The teachers emphasized the fact that the students came prepared for the lessons as a factor for them being more motivated in the learning situation at school. This shows that knowledge of different learning strategies is important and may give teachers a foundation in pedagogical practices that benefits the students [5, 6]. The results show that it is a prerequisite for many students' motivation and how they can create ownership of their own education, and gradually become more conscious learning students who see the connection between their own learning processes and their own learning outcomes [4, 6]. One of the teachers believed that the students' motivation for using technology in teaching can be implemented at any level of facilitation. By connecting practice and theory, students became aware of some of the possibilities and limitations of technology. NOKUT claim that there is a connection between experiencing high expectations of students and their motivation. Students become more motivated by having clear expectations and motivation means that they spend more time on their studies, which is important when it comes to results. Small group sizes of studies contribute to the students' experience of high expectations. It makes it easier to be clearer about what expectations the are for the students, both from the start and through the study. The teachers' focus on good learning activities provided the students with the best possible conditions for acquiring syllabus, theories and practice. Such organizing of classroom activities is fundamental for the students when it comes to being able to understand the basics, and to being able to practice their subject in an optimal way. Time is central to the classroom. The focus is on collaboration between students, active learning and guidance. At the same time, it is emphasized that student-centered teaching creates motivation; which is what the flipped classroom is based on. One of the teachers specifically pointed out that telling the students what was expected from them actually motivated the students in the classroom. By creating a good learning environment and situations stimulate increased participation, motivation is created in the student [13]. Use of video and participation in a group shows that the cognitive and sociocultural view of motivation can complement each other. Flipped classroom facilitates this and feedback from the informants shows that the method helps to increase the motivation among the students [4]. Language is central to learning, and students' interaction with others is the starting point for learning and development of higher mental functions, which is in line with Vygotsky´s view of learning [13]. Use of flipped classroom facilitates more time for students to communicate with each other and with the teacher. According to Vygotskij the importance of language is then central to these learning and development processes. Motivation is central of learning [13].

6 Conclusion

This study shows in which way teachers experience extended motivation from students by using the flipped classroom method. The use of flipped classroom changes from teacher to students centered teaching. By this, the teaching changes both for teachers and for students. This strategy builds on a sociocultural learning perspective. In this study, the teachers created a good learning environment and situations that increased participation and cooperation, which in turn generated motivation and willing students. Teachers perceive video of theory in advance of the teaching session as motivated the students, and gave better knowledge of each student's academic level.

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The Framework for Development of Constructivist Web-Based Learning Environment Model to Enhance Critical Thinking for Primary Students

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Abstract. The purpose of this research is to synthesize the develop Framework of constructivist web-based learning environment model to enhance Critical Thinking for primary students. Model research was employed in this study (Richey & Klein, 2007), which focuses on processes of design and model development. The research procedures consist of three major steps: (1) document analysis and examination of learning and teaching context, (2) analyzing related principles and theories such as learning theory, Constructivist theories, Critical thinking, media theory and technology, and (3) synthesizing the theoretical framework and designing framework for Constructivist web-based learning environment model to enhance Critical thinking based on the reviewed principles and theories. The participants of this study were experts from various fields such as theorists, designers, developers, evaluators, researchers, and learners. The results of the study show that there are five basic elements of the theoretical framework includes (1) psychological base, (2) pedagogical base, (3) contextual base, (4) Critical Thinking base, (5) Media theory and Technology base, and. The designing framework has four mains components as following (1.) The activation of cognitive structure and enhance critical thinking, (2.) The enhancement of cognitive equilibrium, (3.) The support and enhancement of cognitive structure and critical thinking, and (4.) The enhancement and support of knowledge construction and helping of critical thinking, and the designing frameworks has 8 elements as following: (1) Problem base, (2) resources center, (3) Related communities Center, (4) Collaboration center, (5) Cognitive tools, (6) Critical Thinking center, (7) Scaffolding center, and (8) Coaching center.

Keywords: Constructivist web-based learning · Critical Thinking · Constructivist theories

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 644–652, 2019.
https://doi.org/10.1007/978-3-030-35343-8_68

1 Introduction

The changing of world society and advancement of technology is influenced society in globalization. This change affects human being need to learn all their life or life- long learning, especially 21 century learning focuses on learning and creative and Critical Thinking skills. However, at present instructional management focuses on transmitting and memorizing information. This results in lacking of Critical Thinking skills of the learners [3, 20].

Above mentioned reasons, it is necessary to adapt the learning strategies to meet the 21 century learners' characteristics. Therefore, the instruction design must be changed in order to foster Critical Thinking skills and knowledge construction rather than passively receive the knowledge. Instructional Design Theory (ID Theory) was used in this design. Crucial theories used as foundation were Constructivist theories: Social Constructivism and Cognitive Constructivism, Cognitive theories: Information processing and the Critical Thinking. These theories may help the knowledge construction and Critical Thinking of the learners, especially in the course Multimedia Production and Presentation for Education. Moreover, the media attribute and symbols system of web base comprises of hypertext, hyperlink, and hyperlink media may support the knowledge construction and Critical Thinking [6, 15, 22].

In the present, science learning emphasize in process learning with learner center. The teacher helps the learners to construct knowledge and achieve the goal by their own selves. Especially, in science teaching and learning process the learners should be active inquiry, discovery learning, and solve problem. This can result in developing the thinking process of the learners in learning Science for Quality of Life Course. This may help the learners to enlarge cognitive structure that have been able to analyze carefully and construct the knowledge in meaningful ways.

For The above mentioned reason, this study intended to design and develop the learning environments to critical thinking skill of Primary students. It may result in developing cognitive skills and critical thinking of the learners in the learning process.

Researchers realize the importance of synthesizing the develop framework of the Constructivist web based learning model to enhance Critical Thinking. This framework may help designer to effectively design the Constructivist web based learning environment model. In addition, it will help to confirm the credibility and provide beneficial guideline for the designer to design the Constructivist web based learning environment model [4–7, 12, 13, 19, 22].

2 Research Methodology

This research is the first phase of the Model research (Richey & Klein, 2007) [18], which focuses on the design process and model development. The process consists of (1) document analysis examine the learning, teaching and context, (2) analyze related principles and theories such as learning theory, Constructivist theory, Cognitive theory, Critical thinking, media theory, and technology, designing of Constructivist web-based learning environment model to enhance Critical thinking, (3) synthesize the theoretical framework. The participants in this phase included experts from various fields such as theorists, designers, developers, evaluators, researchers, and learners. The Model research on the first phase is the Model development. The data were collected by quantitative and qualitative methods. The document analysis and survey were used.

2.1 Research Objectives

The objective of this research is to design and develop Framework of constructivist web-based learning environment model to enhance Critical Thinking for primary students.

2.2 Data Collection Instruments

1. A synthesis of theoretical framework record form for recording the analysis of document and related research.
2. An open-ended survey on students' opinions about the context of learning teaching. Questions are concerned with teaching and studying that can to enhance Critical thinking.
3. A synthesis designing framework record form for recording the analysis of document and related research for designing the learning environment model.
4. The reviewed record form for checking the quality of the designing framework.
5. An open-ended survey of the participants 'characteristics adapted from Richey and Klein (2007).
6. An interview form for the designer and the developer on the design and development processes of the learning environment model, adapted from Richey and Klein (2007).

2.3 Data Collection

The data were collected as the following details:

1. Document analysis. The researcher reviewed and analyses principles, theories, and previous research studies on the web-based learning environment model, which consisted of a variety of fundamentals such as Psychological base, Pedagogical base, Media theory base, Technological base, and Contextual base. Based on the synthesis of these principles and theories, the theoretical framework for model development was developed.
2. Synthesis of the theoretical framework. The framework was obtained from the analysis of related documents and related researcher as mentioned above. After that, they were recorded by using the synthesis of theoretical framework record form.
3. Survey of students' opinions. The students' opinions on learning and teaching context were examined by using open-ended survey on students' opinions about the context of learning teaching.
4. Synthesis of the designing framework, which was based on the theoretical framework and the contextual study of learning and teaching. The data were collected by using the recording form for synthesis of the designing framework.

5. Exploring of the characteristics of the designers, the developers, instructors and learners by using open-ended survey of the participants' characteristics and the development of the learning environment model by using the interview form for the designer and the developer.

2.4 Data Analysis

1. To obtain the theoretical framework, related principles and theories and documents were analyzed and synthesized by using summarization, interpretation and analytical description.
2. The students' opinions concerned the learning and teaching context from the opinionniare were analyzed by using summarization, interpretation and analytical description.
3. The designing framework was analyzed by using summarization, interpretation and analytical description.
4. The experts' assessment concerning the designing of the learning environment model was analyzed by using summarization, interpretation and analytical description.
5. The characteristics of the participants for designing and developing the web-based learning environment model were analyzed by using summarization, interpretation and analytical description.

3 Results of the Study

The results of this study are as follows:

3.1 Theoretical Framework

The results revealed that the theoretical framework consists of 5 fundamental: (1) Psychological base, (2) Pedagogies base, (3) Contextual base, (4) Media Theory and Technological base, and (5) Critical Thinking base (see Fig. 1).

3.2 Designing a Framework of Web-Based Learning Environment Model

The designing framework of Constructivist web-based learning environments model to strengthen students' Critical thinking showed the four stages as follows:

1. The activation of cognitive structure and enhance Critical thinking. The activation of cognitive structure states the importance of the relationship between different underlined theories, which include Constructivist theories and Cognitive constructivist theory (Piaget, 1964), Situated learning (Brown, Collins, & Duguid, 1989), and Critical thinking (Ennis, 2011). It was designed on complex problem context as the component of Problem base [2, 10, 17].
2. The enhancement of cognitive equilibrium. Four theories must be taken into considerations when designing a web-based learning model to enhancement of

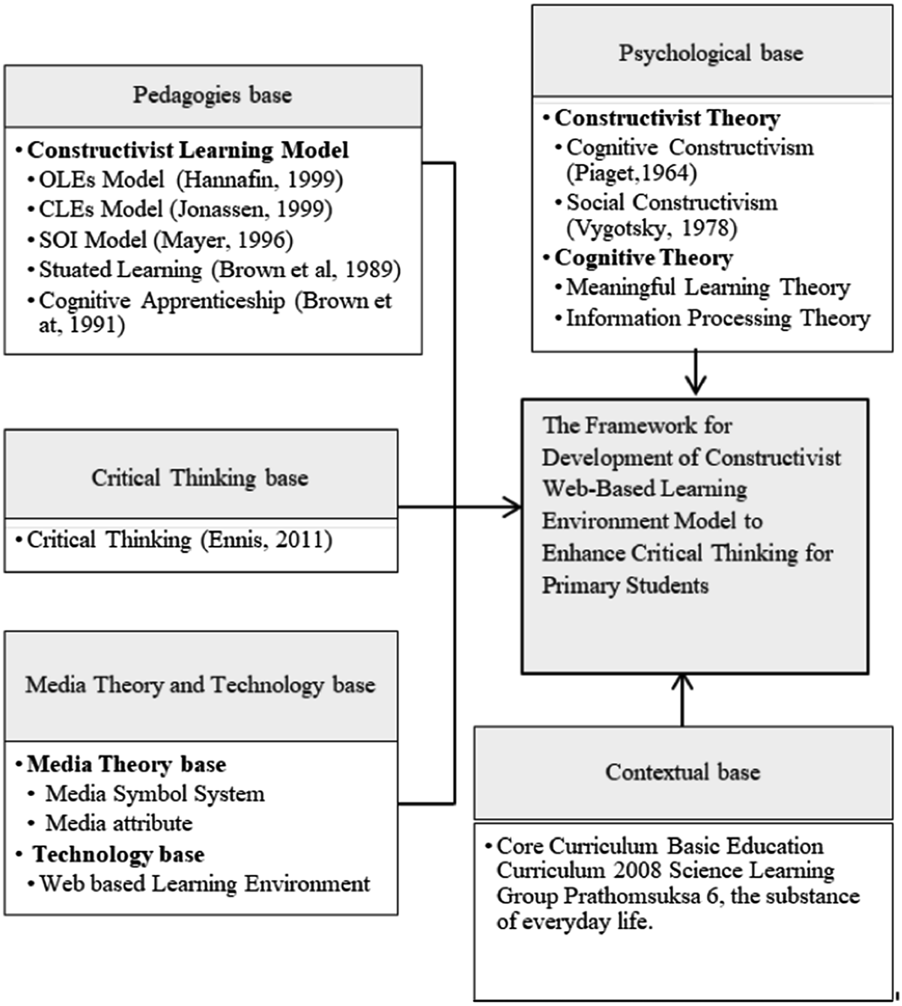

Fig. 1. The theoretical framework for development of constructivist web-based learning environments model to enhance critical thinking for primary students.

cognitive equilibrium. These include Information processing theory (Klausmeier, 1985), Meaningful learning theory (Ausubel, 1963), SOI Model (Mayer, 1996). It was designed as the component of Resources Center. And CLEs (Jonassen, 1999). It was designed as the component of Related communities Center [1, 11, 14, 16].

3. The support and enhancement of cognitive structure and critical thinking. To enhancement of cognitive structure and Critical thinking, the relationship between the following underlined theories must be adopted. These include Social constructivism (Vygotsky, 1978) designed as the component of Collaboration Center, OLEs (Hannafin et al., 1999) designed as the component of Cognitive Tools, and

Critical thinking (Ennis, 2011) designed as the component of Critical thinking Center [9, 10, 21].

4. The enhancement and support of knowledge construction and helping of critical thinking. The relationship between the following underlined theories must be achieved. These include Social constructivism (Vygotsky, 1978), OLEs (Hannafin et al., 1999) designed as the component of Scaffolding Center (e.g., conceptual, metacognition, procedural, and strategic scaffolding), and Cognitive apprenticeship (Collin, Brown, & Neuman, 1991) designed as the component of Coaching Center [8, 9, 21].

The designing framework of Constructivist web-based learning environments model was synthesized based on above mentioned four stage. It can be illustrated in Fig. 2.

4 Discussion

The results of the Framework of the Constructivist web-based learning environment to enhance Critical thinking for model students consists include (1) Psychological base, (2) Pedagogical base, (3) Contextual base, (4) Media Theory and Technology base, and (5) Critical Thinking base, and four stages of The designing framework as followings: (1) The activation of cognitive structure and enhance critical thinking, (2) The enhancement of cognitive equilibrium, (3) The support and enhancement of cognitive structure and critical thinking, (4) The enhancement and support of knowledge construction and helping of critical thinking including 8 elements as following: (1) Problem base, (2) Resources Center, (3) Related communities Center, (4) Collaboration Center, (5) Cognitive tools, (6) Critical thinking Center, (7) Scaffolding Center, and (8) Coaching Center. This research result consistent with study of Chaijaroen, Kanjug, & Watkhawlam (2008), Wattanachai et al.(2005), Kanjug (2009), Kanjug & Chaijaroen (2012) and Samat (2009). The results of this study showed that the elements of the learning environment that can improve students' Critical thinking. In addition, it was found that this designed and developed model was a high quality model, Design elements of the learning environment that promotes cognitive skill and critical thinking of the students. That there is a theoretical basis, (1) the basic psychology of learning, including constructivist theory, cognitive theory (2) basic science instruction focusing on learning environment designed along constructivist and cognitive skills and critical thinking theory (3) fundamental of media Theory and technology such as learning with web-based learning environment (4) based on Pedagogical of learning and (5) based on this principle into context such as student desirable features, guidelines for teaching and the essence of the analysis and design courses. In addition to found that: this models which designed and developed the quality models, which is evident from the evaluation by the various experts found that the content is accurate, right up to date timely. Also, the design and media can encourage students to construct knowledge and enhance their Critical thinking. This may be due to the fact that the design of the learning environment model was based on the theoretical framework and instruction design theories that could translate the principles into practice (e.g., knowledge construction adopting

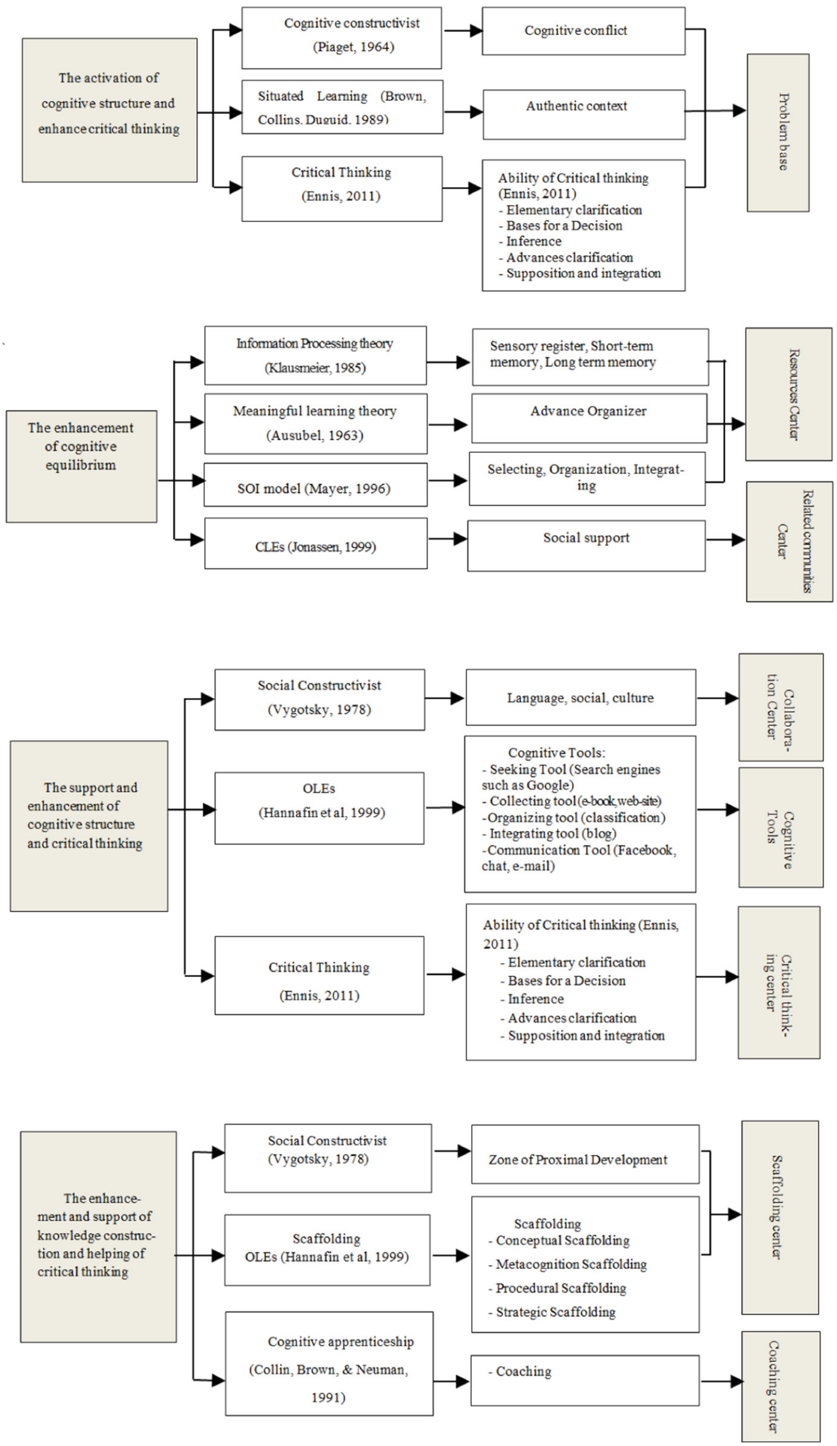

Fig. 2. Design framework for development of constructivist web-based learning environments model to enhance critical thinking for primary students.

the Constructivist theory). Encourage students to solve problem lead to equilibrium. It also has adopted the cognitive skills and critical thinking to design integrated into the critical thinking center that allows students to select knowledge, knowledge deconstruction, adapted knowledge reconstruction, and formation of Critical thinking. These elements encourage students to apply information to new situations. Finally, the findings of this study shed light into the field related to learning environments to enhance students' Critical thinking.

5 Conclusion

The purposes of this study were to design and develop Framework of Constructivist web-based learning environment model to enhance critical thinking for primary students. The theory foundations for the design of model consisted of psychological and learning theory, instructional design theory, communication and message design theory and design and development research. It was synthesized as theoretical framework and learning context as basis in designing framework associating the design elements of the model. of the Framework of the Constructivist web-based learning environment to enhance

Acknowledgements. This research was supported by Ph.D. Program in Educational Technology, Faculty of Education, Research Group for Innovation and Cognitive Technology, Khon Kaen, University, and Research and Technology Transfer Affairs Division, Khon Kaen University which hereby giving the thankfulness all through this.

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Innovative Technologies and Learning in a Massive Open Online Course

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Abstract. The research reported on in this paper presents exciting possibilities to explore how innovative technologies are used to facilitate learning in a Massive(ly) Open Online Course (MOOC). The paper shows how opportunities with regard to e.g. e-books and technologies enhanced learning are being used in ever-changing educational environments, towards the future of open access to education and learning, specifically in an Open and Distance e-Learning (ODeL) environment. The significance of the paper lies in presenting original work contributing to debate in the fields of ODeL and higher education, closing research gaps relevant to innovative technologies and learning, with potentially useful content for the audience, particularly facilitators, including examples of practice regarding massive participation. Although established constructivist or instructionist approaches are usually adopted in pedagogies for innovative technologies, questions are also asked, making the underlying assumptions and theory informing the paper evident. A diversity of research methods implemented regarding MOOCs included data and learning analytics, case studies utilizing user statistics and survey data to examine students' experiences, and investigating models of co-located MOOC study groups, using quasi-experimental comparisons. Discussion and analysis of results in the environment of MOOCs discover lessons learned from the affordances and acceptance of established and innovative technologies and learning for retention and success. Conclusions propose implications regarding MOOCs, including approaches to in pedagogies for innovative technologies. MOOCs' success depends on how well challenges to the future of MOOCs, regarding models towards the scholarship of teaching and learning applied to large cohorts, are managed.

Keywords: E-books · Open access to education and learning · Pedagogies for innovative technologies · Technologies enhanced learning

1 Introduction

The aim of this paper relates to a Massive(ly) Open Online Course (MOOC) presenting potentially exciting possibilities and opportunities to not only explore innovative technologies and learning in a MOOC and multi-dimensional aspects of the use of such technologies for openness in the ever-changing and expanding world towards embracing the future of open access to education and learning, but also the theories, which drive practice [1] and empirically investigate the affordances and acceptance by students of both established and especially emerging technologies in growing capacities

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 653–662, 2019.
https://doi.org/10.1007/978-3-030-35343-8_69

for sustainable Open and Distance e-Learning (ODeL) provision - especially in South Africa and regarding the first-year experience [2]. The research question therefore specifically investigated in this paper is:

- What are the affordances (opportunities) presented by innovative technologies for learning in a MOOC?

The paper's significance lies in presenting original work contributing to academic debate in the fields of ODeL and higher education, in particular [3]. This is accomplished by closing gaps regarding quality research with relevance to the conference theme, and potentially useful content and interest value for the intended audience, particularly facilitators, with examples of practice relating to massive participation [1].

According to Bates [4], the organization and management of social learning on such a massive scale, without the loss of potential advantages related to collaborating at such a scale is still a major challenge remaining to be adequately addressed. Similar to that of Fischer [3], this paper not only reports on collected data regarding existing practices, but also investigates the advantages and disadvantages of different design choices, in order to help identify the e-learning practices worth preserving [5].

Although much can be deduced by relying more on student and/or lecturer feelings and perceptions, there is a need to represent "perspectives on MOOCs from outside Western" environments, based on actual cases [4, p. 147].

Baggaley [5] (referring to Liyanagunawardena, Adams and Williams) agrees that reporting on North American MOOC practices does not provide any evidence regarding the transferability of these to other regions, where some students are literally studying "in a village in Africa", as had somewhat contemplatively been expressed by Fischer [3, p. 151]. In a slightly earlier article, Baggaley [6] (again citing Liyanagunawardena, et al.) also indicated that MOOC evaluations, which are now emerging, are finding that claims regarding courses, which are supposed to be appropriate for worldwide adoption, are groundless. Fischer [3, p. 155] agreed that the particular challenges related to "courses reaching beyond the borders of individual countries" should be considered.

Although indications are that established constructivist or instructionist approaches to pedagogy are usually adopted in relation to the curriculum development, pedagogy and assessment of MOOCs, questions are also asked to make the underlying assumptions and theory informing the paper evident [7].

A diversity of research methodologies implemented regarding MOOCs included heuristics, data and learning analytics, utilizing a case study [8], using user statistics and survey data to examine students' experiences and reporting on studies investigating co-located MOOC study groups, using quasi-experimental comparisons [4, 9].

This paper discusses and analyses results on survey data about the environment of this MOOC, to discover lessons learned from the affordances and acceptance of innovative technologies when used regarding student support for retention and success [10].

Conclusions propose calls considering implications regarding MOOCs, including multimodal approaches to pedagogy and research in the discipline of Information Communication Technologies [11]. It is important to identify challenges for the future of MOOCs [3], faced regarding the scholarship of teaching and learning applied to large cohorts [6], as the success of MOOCs depend on how well these are managed.

Similar to Jona and Naidu [1], referring to Bates [4], this introduction has now provided a useful point to start, by summarizing this paper, in order to draw some lessons learned, based on theoretical groundings, and qualitative and quantitative data [3].

2 Literature Review

The fact that MOOCs tend to not be based on instructional principles that are widely accepted was lamented by Baggaley [6], and as this same author indicated that studies evaluating early 'connectivist MOOCs' have indicated pedagogical deficiencies in these, it would be essential to consider this as well.

Similar to what was reported with regard to one of the very first MOOCs, the author is of the opinion that the particular course reported on in this paper has a solid pedagogical approach and includes the use of open educational resources [1, 3, 11].

Although designing MOOCs is undergoing rapid curriculum development with regard to pedagogy and assessment, a lot has already been established about ODeL, which needs careful application and supervision when instructionally designing MOOCs [4].

According to Diver and Martinez [10, p. 5], it is not correct considering MOOCs as wholly different entities, "outside and apart from other types of" distance education and e-learning environments. Baggaley [11, p. 369] agreed that very little about MOOCs "is actually new, and plenty of lessons are available about how" these can be implemented; Jona and Naidu [1, p. 142] therefore asked what lessons from existing e-learning "and mainstream distance education research" can contribute and what the unique technological innovations are, which support the design, implementation, analysis, delivery and/or evaluation of MOOCs.

The use of alternate systems to improve instructional design, as well as innovative technologies to facilitate improved teaching and learning quality [12], should be considered towards student support for retention and success [13].

A team approach was followed, with the team including individuals "trained in instructional design, the learning sciences, educational technology, course design or other educational specialties to help with the design of their courses" [11, p. 373] (quoting Holden). The online development and curriculum design of the course was informed by an environmental analysis, liaison with industry and/or professional bodies and other relevant stakeholders, and/or relevant market research, including applicable quality assurance criteria in terms of the planning process.

The elements developed mentioned in the previous paragraph were augmented by readings, problems, assignments and a portfolio, as well as enrichment components such as peer-to-peer learning support and automatic grading to provide support to the sizeable number of students in these e-learning environments being added [3]. Since Li et al. [9] suggested that MOOC students prefer studying in groups, social facilitation within such groups could make learning difficult concepts a more pleasant experience, e-learning forums for supporting the importance of self-directed, problem-based and active learning, as well as peer-to-peer learning and fostering collaboration amongst students, and interactivity, for providing feedback, were also implemented [3].

According to Baggaley [11], lecturers and policy-makers are facing the increased costs of infrastructure and of teaching an increased number of students using fewer resources [3]. Firmin et al. [8] pointed out that HEIs therefore increasingly consider the integration of MOOCs into their overall curriculum and course activities by including support services, with enrolment sizes being similar.

Students are teaching each other and grading each other's work [11], as well as taking responsibility to digest the information being presented to them to discuss it with other students [5]. Since, however, Baggaley [11] reported on the huge amount of information available in these discussion forums, this same author [5] (referring to Knox) warned that numerous MOOC students are crushed by this peer-to-peer approach.

The author agrees with Baggaley [6] that it is impossible for a single lecturer to handle such massive student numbers, and Fischer [3, p. 152] that the students can be disorientated by the "volume of ideas and comments". These problems can be addressed through the establishment and support of curator roles for organizing the potentially large information spaces - in the course discussed in this paper, they were called Teaching Assistants (TAs). This would be as opposed to the situations described by Baggaley [5], for a course that dispensed with teaching support, and in another instance, where courses are unsupervised, lecturers played no role in the appointment and monitoring of teaching assistants, nor provided these facilitators with any training [11].

Such human tutoring can take the form of assignment marking of individual students, as well as tutors to support the forums for operating more successfully and/or to support students experiencing problems "with content and/or technical issues" [3, p. 154].

While learning has taken place in both open and distance environments, MOOCs have increased the size of student enrolments [5] to situations where participation numbers "in the tens of thousands" [7, p. 164] of students in a single course [11]. The large enrolment numbers associated with MOOCs underscores the importance of engaging in e-learning student support for retention and success with regard to educational activities [8], which compelled Diver and Martinez [10] to investigate issues related to MOOC dropout, with high non-completion rates in MOOCs also being reported on [1].

According to Jona and Naidu [1], the essay by Marshall [2] explored the ethical considerations relating to this new educational approach and research findings, which must serve to guide the decision-making of key stakeholders – the latter including students, individual faculty members and/or higher education institutions' online support services, coordinators, leaders and administrators, who consider the implementation of MOOCs in their organisations [8].

Finally, Marshall [2, p. 250] indicated that there are significant "research ethics concerns arising from" various initiatives around the "analytical and other work being done by academics and" HEIs, with regard to specifically MOOCs. Similarly, Jona and Naidu [1] also raised concerns, which many lecturers and distance education researchers share: Baggaley [5, p. 162] is of the opinion that "the ethical approach taken by Marshall" [2] "may ultimately pose the unarguable challenge that decision-makers cannot ignore." Both Baggaley [5] and Jona and Naidu [1, p. 143] therefore encouraged all those HEIs who participate in the development, administration and study of "MOOCs to pause and consider the many important implications of this new technology and" the ethics of these and associated practices and policies.

2.1 Scholarship of Teaching and Learning

Huber and Morreale [14] explored common ground regarding disciplinary styles in the scholarship of teaching and learning.

While Hatch [15] looked at taking the development of the scholarship of teaching and learning into the classroom, Richlin and Cox [16] investigated new directions in terms of developing scholarly teaching and the scholarship of teaching and learning through faculty learning communities. In the same kind of scenarios, in their capacities as faculty luncheon speakers, in Dawson et al. [17]:

- examined assessment alignment as a process for program evaluation,
- carried out a quantitative investigation into collaborative testing to improve learning,
- used case-based learning in undergraduate Biochemistry education, regarding design, implementation, and pedagogical outcomes,
- studied teaching evaluations and the Scholarship of Teaching and Learning (SoTL) for continuous improvement,
- considered peer review, writing and presenting in undergraduate courses, in terms of how teaching innovation and teaching/learning research can be united,
- researched how to collect, analyze, and present qualitative data,
- investigated quantitative and qualitative analysis of courses and students, and finally,
- explored SoTL opportunities arising from designing a 'Biological Concepts of Health' course.

With regard to methodological issues, according to Boucher and Piderit [18], the application of an action research process is a method commonly used to demonstrate scholarship in higher education teaching – the latter authors offered their reflections on an Undergraduate Information Systems (IS) Software Development Project (SDP).

2.2 Learning Analytics

According to Willis, Slade and Prinsloo [19, p. 881], learning analytics' growth as a means for improving learning outcomes means that student data is being collected, analyzed "and applied in previously unforeseen ways." The latter authors therefore derived a typology from a cross-continental, cross-institutional perspective, as Bolton, Goosen and Kritzinger [20, p. 1] are of the opinion that the influence of such social change needs to be "discussed, highlighting the new requirements" with regard to the ethical oversight of student data in learning analytics.

3 Research Methodologies

Including a suitable methodology for the non-experimental descriptive research design chosen, the mode of inquiry or research approach reported on in this paper was mainly quantitative. While the broader study contained aspects of a mixed method strategy, in this particular case, a triangulation design, where "both qualitative and quantitative data" were collected at the same time [21, p. 25]. Although Goosen and Mukasa-Lwanga [22] also worked in a distance education environment, that particular conference paper presented mainly qualitative perspectives.

While Firmin, et al. [8] utilized a case study on using MOOCs for conventional college coursework in a distance education environment, the chapter by Goosen [23] used a case study of a massive open online course to highlight technology-supported teaching and research methods for academics.

3.1 Data Collection Strategies

Fischer [3] indicated that iterations driven by formative evaluations were pivotal in terms of learning from their shortcomings and mistakes.

3.2 Validity and Reliability

Towards ensuring reliability, Maree and Van der Westhuizen [24] explained that this could be achieved, for example, through the triangulation of data. The latter authors (quoting Maxwell) indicated that validity is not inherently a property of any one particular method, but, instead, is related to the data, accounts and/or conclusions, which are reached through using that particular method in an environment for a specific purpose.

3.3 Data Analysis

Although Archer, Chetty and Prinsloo [25] referred to the potential of harvesting and analyzing the digital data produced by students, towards offering customized assessment, curricula and support, that is not the route that had been taken for the data collected with regard to the research reported on in this paper. Instead, the rich data, which had been gathered during surveys, were analyzed [26], especially regarding the more qualitative aspects, by using content and interpretive analysis.

Analysis was concerned with how artefacts were being used, and the purpose(s), which these were used for [21]. As researcher in an interpretive paradigm, Goosen [27] mostly preferred inductive data analysis, as this was more likely to help in the identification of the multiple realities, which were potentially present in data [24]. Also, as an interpretivist researcher, the author therefore carried out this particular study in the 'natural' environments as described by the students, towards reaching the best possible understanding, since the realities of students' experiences could not be comprehended in isolation from the environments in which these occurred. Finally, data were also analyzed in light of literature as reviewed, to consider how the results compared and/or contrasted with previously completed studies.

More details with regard to the methodologies used for research in this course, in terms of a description of e.g. the research design, population and sampling, data collection, validity and reliability, as well as data analysis, can be accessed in [23] and [27].

3.4 Trustworthiness

Whereas Maree and Van der Westhuizen [24] argued that, especially in qualitative data collection, in-depth responses from individuals secured sufficient levels of validity and reliability, another argument is that such grounds were insufficient to ensure validity and trustworthiness. A number of authors suggested paying attention to dimensions, which included confirmability, credibility, dependability and transferability, in order to increase the trustworthiness or reliability of especially the qualitative aspects of studies.

3.5 Ethical Aspects

For more detail on the ethical aspects of both the research, as well as how these were specifically addressed in this MOOC, the reader can access [28]. Ethical data management and research integrity in environments, such as those described in this paper, are also discussed in [29].

4 Discussion and Analysis of Results

Reporting on the low completion rates for MOOCs, Fischer [3] indicated that only about 4% completed their courses, while Baggaley [11] reported that only 14% of their participants completed the course. In sharp contrast, the MOOC reported on in this paper (see Table 1 in [28]) has shown completion rates (number of students registered at the time of mark sign-off divided by number of students who completed the final portfolio) as high as 89% for the first semester of 2014. The percentage of students who pass the course has stood at a constant of 84% since the second semester of 2014.

Similar to Knox [7], this paper discusses, and analyses results as specific examples of the massive participation derived from survey data about the environment of this MOOC [10]. Likewise, Fini [30] had also reported on and analyzed the range of students' positive reactions to these courses, most of them enthusiastic, in order to discover some lessons, which can be learned and drawn from students' opinions about the affordances and acceptance of established and emerging technologies in terms of the array of social media technologies made available when used with regard to student support for retention and success [11].

Fischer [3] also reported that for the course reported on in that article, an average of only around 50% of those students, who were registered for a specific course ever viewed the learning materials.

The fact that the Discussions technology was the one most used by students to communicate with their online tutors (teaching assistants) could be attributed to a guideline given to students, that they should contact their teaching assistants via this technology.

Please note that more statistical analysis results for this course, including e.g. details on the different countries these students come from, are available in [31].

More results to show the actual application of the research approach can be found in [23], reporting on e.g. completion rates and students' participation in (online) tutorial activities, as well as [27, 28] and [31], indicating that students in this MOOC do want access to e-learning.

5 Conclusions

The challenges discussed in the introductory section of this paper could also include whether students could learn what they wanted and when they wanted it, as well as providing access to individual students, which they would not have had otherwise [3]. [32] added more results around students' access to this Information and Communication Technologies for Development MOOC, to show the actual application of the research approach.

According to Firmin et al. [8], critical aspects that should be included are related to early and consistent interventions, which have been designed for helping students to engage sustainably and stay on track. By encouraging and supporting student effort and engagement, not only can persistence be increased, but results could also be substantially improved towards success for all students.

Students get involved in learning activities, where those activities are presented in a course [3] with more inquiry-based and added real-life content that contextualize the material [8] and engage students in personally meaningful problems and/or when they are learning about something, which they find exciting [3].

According to Diver and Martinez [10, p. 21], MOOCs generate tremendous amounts of data, which "can be used not only" for improving the MOOCs themselves and their associated e-learning environments, but can also act as a reference to analyze and reflect on "past, current, and future MOOC developments" [3, p. 149].

In an attempt to assess the significance of distance education at the scale of MOOCs, like that of Knox [7, p. 164], this paper analyzed a specific example of the massive participation derived from e-learning and distance education, "a MOOC from the University of" South Africa. User statistics and survey data were used to illustrate and for the examination of the students' experiences and engagement with educational activities where average registrations exceed 15,000 per semester. This was in response to Baggaley [5, p. 162] calling for the consequences regarding effectively "learning for the vast majority of participants who took" part in MOOCs needing to be established.

As Knox [7, p. 173] indicated that since some students responded to the "massive participation in ways that can be interpreted as" them being overloaded and/or feeling anxiety, additional work is needed in the fields of open and/or distance education for considering how to work with a global audience that has significantly different experiences and beliefs about education".

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Learner's Creative Thinking Learning with Constructivist Web-Based Learning Environment Model: Integration Between Pedagogy and Neuroscience

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Abstract. The Purposes of this research were: (1) to examine learners' creative thinking (2) to compare pretest and posttest of the learners' creative thinking for measuring and evaluation of executive function by using Torrance Tests of Creative Thinking (TTCT). The Model research Phase III Model Use was employed in this study. Both quantitative and qualitative data were collected and analyzed. Mean, standard deviation, percentage and Z test, Wilcoxon Matched-pairs Signed rank test and protocol analysis were used to analyzed the data. The target group was 27 learners of the 2018 academic year at Banhaedsuksa School. The results showed that: (1) The students' creative thinking 4 aspects including: (1) fluency (2) flexibility (3) originality and (4) elaboration and (2) The comparison of the pretest and posttest of the learners' creative thinking, from measuring and evaluation of executive function by using Torrance Tests of Creative Thinking showed that standard scores total activity of posttest all students were significantly higher than standard scores total activity of pretest at the level 0.05

Keywords: Constructivist · Web-based learning environment · Neuroscience · Creative thinking

1 Introduction

Technological advances have great impacts on learning process of people in the 21st century. Learning management, therefore, has to be adapted to correspond to today's world. Learning in the 21st Century needs to go beyond "traditional subject themes" towards "21st Century skills," abilities that cannot be taught by teachers. As a result, development of learning skills and knowledge construction are necessary tools in grasping ample of information available in today's technology. As Chaijaroen [1] puts it, knowledge construction is an important instrument in linking one's existing experience to new knowledge, which leads to an effective problem-solving process. This is consistent with Thailand's Education Reform Policy in the Second Decade, B.E. 2552–2561 (2009–2018) [2] which focuses on the improvement of education quality and

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 663–671, 2019.
https://doi.org/10.1007/978-3-030-35343-8_70

offers of learning opportunities to Thai people, and encouragement of more involvement from every sector in education management, as prescribed in Thailand's National Education Act, B.E. 2542 (1999) amended (3rd Issue), B.E. 2553 (2010) [3]. It is very urgent to develop and foster the efficiency of the Thai among the fast moving of economic world which requires the human to be skillful in science, math, and creative thinking to be able to confront and solve a problem effectively, which consistent with the learning in 21st century about the Creativity and Innovation development. Including the Eleventh National Economic and Social Development Plan 2012–2016 which focuses on creative thinking. The creative thinking is higher-order thinking, the ability to think or find a solution in multiple ways by connecting the prior knowledge with the new knowledge into a new work or production or to solve a new problem [4]. Therefore the creative thinking is not only the ability to use in learning, but it can be used to solve a problem in different situation.

The current learning paradigm has been shifting from "teaching" to "learning" which most importantly focuses on the learners. In addition, the development then could be enhanced by using information technology for life-long learning. Furthermore, the unreachable of achievement in basic education school management according to the national standard. This might cause from the lack of learner-centered and thinking enhancement especially in analytical, critical, and creative thinking.

One of the learner development for such mentioned enhancement according the national education plan is to design the instruction based on pedagogy as Cognitivism which foster the learners to create and have their own cognitive process, Constructivist which mainly on knowledge construction along with creative thinking in area of information and technology consistent with learning 21st century. Especially in task presentation by using information and technology which requires the originality and presentation in more multiple ways fluently and quickly. This corresponds to the creative thinking [5]: fluency, flexibility, originality, and elaboration.

Moreover, the study of recent studies was found that the results mainly showed creative thinking in cognitive process based on learning theory, but insufficient for the study of what happen in cognitive process of the learners. Therefore, the integration of Pedagogy and Neuroscience in terms of methods and equipment was focused in this study. Qualitative and quantitative data collection with biomarker can show the empirical evidence of its cognitive process. The study of creative thinking by evaluating of executive function along with protocol analysis based on Guildford [5] is one of the study that integration Pedagogy and Neuroscience. Designing the constructivist web-based learning environment and creative thinking according to Cognitive theories and Cognitive neuroscience. This kind of study is not the study of behavior observation but it is the enhancement of learner's cognitive process to help them to be able to construct knowledge and confront the authentic problem in real life situation. The knowledge construction is enhanced by the connecting of prior and new knowledge through schema along with media attributes and media symbol system by each learner's processing ability affected to their learning ability [6, 7]. The web-based learning with hyperlink, hypertext, and hypermedia can help the learners to construct knowledge as each node of knowledge connection can link more and more. This can help the learners elaborate knowledge by their own selves.

As mentioned above, the researchers hence realize the importance of the design and development of the constructivist web-based learning environment to enhance Creative thinking, and intend to study the Creative thinking of the learners. The finding finally may beneficial to enhance the learners to have more creative thinking and learning efficiency. Furthermore, the integration of neuroscience of methods and equipment could showed the empirical evidence of cognitive process. Such results so could be used to develop the human resource and 21st learning century for the stability of knowledge and economic society.

2 Research Purpose

- To study the creative thinking of the learners who learned with the Constructivist.
- To compare the pretest and posttest of the creative thinking between before and after learning with the environment by evaluating the executive function through Torrance Tests of Creative Thinking (TTCT).

3 Research Methodology

- The target group was 27 learners of the 2018 academic year at Banhaedsuksa School.
- The Model research Phase III Model Use [8] was employed.
- The research instruments used in the experiment and collecting data comprised of (1) the Constructivist web-based learning environment model to enhance creative thinking on the topic of Presentation (2) of the learners' interview on creative thinking and Torrance tests of Creative Thinking; TTCT).

4 Data Collection

The data were collected as following these steps:

- Administration Torrance Tests of Creative Thinking (TTCT) to the learners before they learned with the learning environment.
- Divide the students into eight groups, each group consisted of three learners and allowed them learning with the learning environment by starting to provide a introducing them about how to learn with the learning environment in order to provoke them to get preparation and concentration to learn.
- They learned with the learning environment and completed the tasks to enhance creative thinking by using 8 components as (1) Problem base, (2) Knowledge bank, (3) Cognitive tools, (4) Creative thinking enhancement room, (5) Collaborative room, (6) Coaching, (7) Related cases, and (8) Scaffolding. Then, the researcher summarized the lesson together with them in the end of the class.
- The learners took the TTCT after learned with the learning environment.
- The students were interviewed their creative thinking by the researcher.

5 Data Analysis

The quantitative and qualitative data were analyzed as the following:

- The creative thinking of the students was analyzed by protocol analysis based on the framework of Guilford [5], summarization, interpretation and analytical description.
- The creative thinking of the students from the evaluation of executive function by using TTCT was analyzed by using descriptive statistics which were mean, standard deviation (S.D.), percentage and Z test, Wilcoxon Matched-pairs Signed rank test.

6 Research Result

The results of the learners' creative thinking who learned with Constructivist web-based learning environment were as follows:

6.1 Creative Thinking of the Learners

The results of interview and protocol analysis were found that the learners' creative thinking who learned with Constructivist web-based learning environment on the topic of Presentation consisted of 4 aspects: (1) Fluency which were Word fluency and Associational fluency, it showed the students' ability to find the answer quickly by naming of 27 presentation patterns in limited time of 1 min and comparing the advantages of publications media as convenient to use and distribute, the disadvantages of such media as no sound and unable to present animation and picture like video, to suddenly edit work, and waste of papers, advantages of electronic files as able to present animation picture as video, sound effect, make more interesting, and fast edit, and disadvantages of such files as cots a lot of investment if have no background or expertise in technology also difficult to present if have no computer or specific program to open the files or resolve virus problems; (2) Flexibility was the ability to create multiple concepts by be flexible to adapt or adjust presentation styles such as in project or exhibition or presented through a software as Word, Photoshop, e-book, video or web site (3) Originality was the ability to use the knowledge to create a concept that new, originate, and different from the previous concepts which they designed and created the presentation from the provided pictures, and it was found that they presented in exhibition pattern by stimulating places or objects and (4) Elaboration was the ability to elaborate the main concepts until completion which they added an idea to their presentation of The 12 value by summarizing the each main idea, adding cartoons, effects, videos, or music to make more understating to its details which such result consistent with Creative thinking framework of Guilford [5].

6.2 The Pretest and Posttest of Learners' Creative Thinking from Measuring and Evaluation of Executive Function by Using Torrance Tests of Creative Thinking (TTCT)

Tables 1 and 2 The pretest and posttest of learners' creative thinking from measuring and evaluation of executive function by using Torrance Tests of Creative Thinking (TTCT) Form A: Figural and A: Shape (Fig. 1).

Table 1. The pretest and posttest of learners' creative thinking A: Figural

Creativity dimension	Type A (shape)	
	Pre-test score total activity (Acvt. 1–3)	Post-test score total activity (Acvt. 1–3)
Fluency	92.18	110.18
Originality	113.89	135.07
Abstractness of titles	99.66	122.40
Resistance to premature closing	100.11	129.40
Elaboration	98.66	122.92

*Significance at the level 0.05

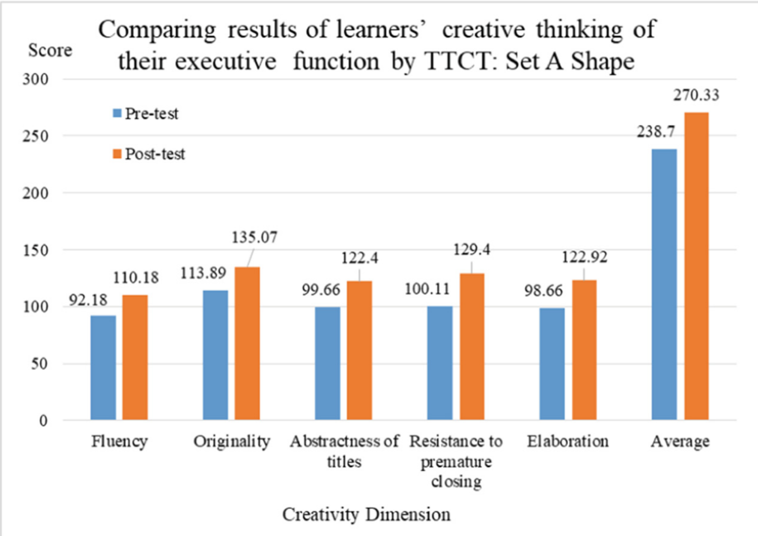

Fig. 1. Comparing results of learners' creative thinking of their executive function by TTCT: Set A Shape A.

Table 2. The pretest and posttest of learners' creative thinking Form A: Verbal.

Creativity dimension	Type A (verbal)	
	Pre-test score total activity (Acvt. 1–7)	Post-test score total activity (Acvt. 1–7)
Fluency	92.18	110.18
Originality	113.89	135.07
Flexibility	80.92	92.03
Average	504.51	620.00

*Significance at the level 0.05

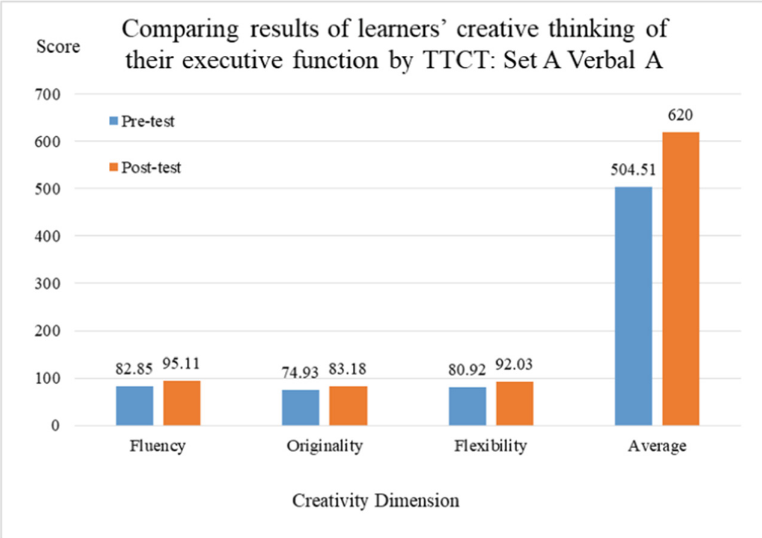

Fig. 2. Comparing results of learners' creative thinking of their executive function by TTCT: Set A Verbal A.

The students' creative thinking scores from TTCT: Form A: Shape showed the posttest scores (270.33) higher than pretest score (238.70) and scores of students' creative thinking from TTCT: Form A: Verbal showed the posttest (620.00) higher than pretest score (504.51) significantly at the level of .05 which means they have more efficiency on creative thinking (Fig. 2).

7 Discussion

7.1 Learner's Creative Thinking

It was found that the students had the creative thinking from protocol analysis which were Fluency, Flexibility, Originality and Elaboration. This finding was consistent with the studies of Ditcharoen [9]; Samat [10]; Teerawat [11]; Sujamnong [12]; Chaijareon and Samat [13]; which found that the learners have the ability to think creatively as fluency, flexibility, originality and elaboration, also able to expand and extend the idea outside the scope. The results of this study might cause from the design which based on theoretical principles in both Constructivist that focus on constructing knowledge and Cognitivism theory that focuses on the learning process, especially in Guilford [5] creative thinking framework. The design was provided for the learners to have an opportunity to develop their cognitive processes though creative learning tasks as in the Creative thinking enhancing room where they could thinking creatively as the empirical evidence showed that "The Creative thinking enhancing room was fun and if I could think fluently because it had limited time and also I could understand more after doing exercise" or "Flexibility room makes us to find something new to replace the old one, or to the new program to replace Power point program such as Proshow Gold, Prezi, Powtoon" or "Originality room enhanced us to think based on our experiences in daily life and applied to a new thing to attract audiences and make more interesting" and "Elaboration room helped us to expand my ideas from my old one and can be create a new thing and have expand more ideas." Such findings consistent with the Creative thinking of Guildford [5] which its 4 aspects emphasize on connecting to prior knowledge to create a new idea or solution.

7.2 The Comparison of Learners' Creative Thinking from the Evaluation of Executive Function by Using Torrance Tests of Creative Thinking (TTCT) Before and After Learning

The results revealed that the posttest scores were higher than pretest scores from the evaluation of executive function by using Torrance Tests of Creative Thinking Form: A Shape and Language. This showed that the learners developed their creative thinking which consistent with the studies of Srikampha [14]; who studied the development of creative thinking. This showed that the learning that conducted the evaluation and used TTCT hence was the learning with Cognitive activity and effected from Brain activity. This evidence showed the relationship between brain area and creative thinking activity that there are many areas are provoked by learning [15, 16]. Also, the study of fMRI which about the thinking sharing from confronting and provoking, it shows the results of creative thinking evoking in Temporo-parietal and Frontal area which then more creative thinking [17]. Moreover, the study of creative thinking from the analysis of Cortex difference during activity through brain wave and solving problem tasks, it was found that Frontal area was efficiently in creative thinking examination [18]. Regards these studies, the learning with the Constructivist web-based learning environment to enhance creative thinking could hence enhanced the learners' creative thinking by the evaluation of executive function directly to learning development, for example; reading for comprehension or integration with new information to understand the learning content. Executive function is the thinking process in Frontal area which work as CEO to input data and analyze, synthesize, and solve a problem before output and protect to react automatically by realizing, considering, and adjusting thoughts in order to reach success [19].

8 Recommendations

The further study should be studied about other factors such as gender, age, emotions affected creative thinking in order to develop a Constructivist web-based learning environment, media attribute affected creative thinking for using such attributes to design and develop the web-based learning environment more efficiently and brain wave or specific brain area affected learners' creative thinking for more useful in development and enhancement of learners.

Acknowledgements. This research was granted from the National Research Council and supported by Research Group for Innovation and Cognitive Technology, Khon Kaen University.

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Pedagogies to Innovative Technologies

Focus on Personalized Collaborative Learning: What Can We Learn from the Indigenous Sámi Teachers' Supplementary Study Program on Digital Learning Tools?

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Abstract. The aim of this study was to find ways to modernize Sámi language teaching and teaching in the Sámi language with digital technology. We realize the importance of digital technology in enhancing the sociocultural position of minority and Indigenous languages. However, the lack of teaching and learning material in the Sámi language is still challenging. Free digital teaching and learning tools could help produce and provide learners with multimodal learning material and new ways of learning. Moreover, competencies in the use of digital technology are an internationally accepted key element of teacher education. The Focus on the North–Digital Learning for Pre- and In-Service Teacher Education Project, funded by Norgesuniversitet in cooperation with the Sámi allaskuvla - Sámi University of Applied Sciences (SUAS) in Norway and the University of Lapland in Finland, aimed to address challenges affecting education in the Arctic educational context by creating a 15-credit (ECTS) course program with three courses on digital tools in education. SUAS practice schools are in Norway, Finland, and Sweden, so distance learning and teaching didactics were designed as the core of this project. Student teachers and in-service teachers at all education levels participated in the courses. The findings indicated that teachers' and student teachers' experiences of personalized collaborative learning in using digital teaching tools to support Sámi language teaching were remarkable in practice, as teachers gained access to tools for coping in a demanding educational context. Digitalization provides new ways to improve learning in a threatened language context.

Keywords: Sámi language and education · Digital teaching and learning · Arctic context · Pre- and In-Service Teacher Education · Collaborative learning

1 Introduction and Background

The Focus on the North-Digital Learning for Pre- and In-Service Teacher Education Project by Sámi University of Applied Sciences (SUAS) and its partners seeks to transform the teaching of the Sámi language, and improve its quality with innovative

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 675–684, 2019.
https://doi.org/10.1007/978-3-030-35343-8_71

use of digital tools and media. Teaching at SUAS is conducted in the North Sámi language, providing education to Sámi people from Norway, Finland, Sweden, and Russia. However, the Sámi language has several challenges. In addition to a lack of resources and learning materials, there is, for example, a dire need for competent educational personnel to teach the Sámi language. For these reasons, it is critical to devote efforts to enhance digital competencies in Sámi language education, as digital tools provide new opportunities, and may resolve many of the challenges in Sámi language learning and teaching. This project was a step toward strengthening teacher education in digital teaching and learning.

The SUAS Sámi Primary School Teacher Education Master's Degree program for Grades 1–7 and 5–10 was accredited by the Norwegian Agency for Quality Assurance in Education (NOKUT), at the same time that Norway adopted master's programs in primary school teacher education. The Grades 1–7 program concentrates particularly on initial Sámi language and mathematics education, and the program for Grades 5–10 focuses on Sámi language didactics. The accreditation process emphasized that there is a need to support digital learning at SUAS. As these programs were aimed to be conducted partly on campus and partly online, the teaching personnel needed education in digital teaching. In addition, many of the academic personnel lacked competencies in digital learning. In the beginning of the project, it was very clear that there were internal and external needs concerning digital learning in the Sámi education context. NOKUT highlighted in 2017 that SUAS must support teacher education with a focus on digital learning. SUAS has several educators and teaching personnel who have special competence in digital learning, and this group of professionals gathered information and planned the implementation of the project. The writers of this article were responsible for designing a course and teaching in the 15 credit (ECTS) course program about digital tools in education. Keskitalo was the project leader.

In this study, we asked: How did the participants experience digital education courses? How did the personalized collaboration enhance teachers' digital competencies?

The background of the study lies in the theory of cooperative and individualized learning. Supporting group dynamics produces effective results. A working culture can be developed through digital learning and teaching that enhances group and individual performance.

2 Theoretical Framework

Working in a group and reaching your goals in the most positive way possible can be achieved only in a robust working environment. Slavin [16] explained that learning is enhanced through cooperation among students. However, cooperation is sometimes challenging, and some students might not readily share their ideas or be forthcoming with feedback because they are afraid of negative comments from their peers. Johnson and Johnson [8, 9] proposed an educational theory of cooperative learning which hypothesizes that this sort of behavior may be the result of not feeling individually accountable for the end product of the cooperation. The social interdependence theory of cooperative learning emphasizes the significance of the sense of working together toward the same goal [8, 9], which can be achieved with group dynamics, even when working online. The use of digital devices is increasingly incorporated in teaching and learning everywhere in the world. At the same time, there has been a shift in pedagogy from the traditional way of teaching to collaborative ways that have changed the learning development process for students and teachers [20]. It has become clearer that learning happens not only through content but also through peer interaction, collaboration, reflection, and feedback. Thus, learning is a two-fold process, learning about content and learning by doing [1]. Furthermore, today, pedagogical models have been designed to help students take more charge of their learning and education [13]. The importance of a pedagogy that provides autonomy to students is understandable, particularly in the case of distance learning. Tools are needed for developing long-lasting and innovative models for revitalizing threatened languages and cultures, and for counteracting language loss through digital solutions [14]. Seeking ways to promote educational success among Indigenous pupils is valuable after a history of marginalization and subjugation [18]. Thus, providing support for collaborative learning, as well as independent work, is necessary in today's pedagogical approaches.

2.1 Group Dynamics

The efficiency of a group, to some extent, depends on the environment in which the group is working. Thus, a good dynamic among teammates is directly proportional to the environment in which they work. Sweet and Michaelsen [17, p. 34] define group dynamics as "the phenomenon of interaction among team members evolving through well-documented stages and resulting in members of mature groups interacting in very different ways from members of new groups". To understand different stages of group development, one can start with Wheelan's [21] integrated model of group development (IMGD). Harmony in a group requires constant work and collaboration. If communication is not working, then even long-term groups can have problems similar to a new group.

The purpose of group work is to achieve a common goal, whether education related or job related. Team members should consider all members of the group as essential and valuable sources of ideas [1]. Studies have shown that those working in a group and involved in sharing and collaboration learn better than those who do not work in teams [3]. Furthermore, studies have shown that individuals work more efficiently in teams, as they reflect and get feedback, which motivates them more [12, 17]. Working in teams improves not only motivation but also communication skills, interpersonal relationships, trust, and more importantly, leadership skills [5–7].

2.2 Reflection

In group dynamics, constant reflection is essential. It is the most important part of group dynamics, as it makes the learning collaborative and meaningful [11, 19]. Reflection is done individually, and shared in the group. Individual reflection activates the critical-thinking process and students' understanding of their own behavior and role in the group. At the same time, the sharing of one's reflections with the group allows feedback from peers, which, in turn, opens up new thought processes [4]. The timing of reflections is an important factor. Savage, Tapics, Evarts, Wilson and Tirone [15] point out the importance of time and space in which reflection should be done. The study acknowledged that the time and space for personal reflection and exploration significantly increases learning [15].

2.3 Feedback

Feedback and reflection are not byproducts that can be achieved automatically while students work together. Feedback, as well as reflection, requires skills that must be practiced under supervision. Feedback has a set of rules that must be followed while giving and receiving it. Feedback must be timely, should be owned, and given only after receiving permission; it should be for the work that is being conducted, and not be about the person. Furthermore, feedback and reflection go together: A student learns through feedback given by his or her groupmates and by a teacher, as well as through reflection. At the same time, teachers in the classroom are informed about students' learning through the combination of reflection and feedback [11].

3 Methodology

The target groups of this project were SUAS teaching personnel, student teachers at SUAS, partner practice school teachers, and all Sámi teachers and teachers of the Sámi language. In this project, Kautokeino municipality schools in Norway and Utsjoki municipality schools in Finland were the practice school partners.

Before the project began, SUAS identified many development tasks concerning digital learning at the SUAS and practice schools. The project began with careful planning of measures and course topics in which teacher education teaching staff, as well as the administrative and IT personnel from SUAS, participated. A 15-credit (ECTS) program was designed with three 5-credit (ECTS) courses. Participants could take the full course program for credits or take parts of the courses for no credit. The program had 69 participants altogether; 47 in the first course, 15 in the second course, and 7 in the third course. Tuition was free for anyone in the target groups. Project members also attended digital competency seminars, conferences, and courses. Each of the three designed courses had a different objective concerning digital teaching and learning competencies.

The main data collection method was online questionnaires with open-ended reflective questions that were developed separately for each course. An online questionnaire provides respondents not only anonymity and the possibility of responding regardless of geographic location but also the opportunity to answer the questions truthfully, providing trustworthy data. The data were analyzed using inductive and deductive content analysis [2]. The inductive process in the beginning of the analysis leads to deductive thinking and the determination of deeper themes in the data, without forgetting the importance of reflection, as researchers potentially influence the interpretations [2].

3.1 Course 1, Digital Education Theory and Web-Based Solutions

Course 1 was taught during autumn 2017. This course had 47 participants: 17 academic personnel, 15 practice school teachers, and 15 student teachers who participated in different parts. During the course Sámi, Norwegian, Finnish and English languages were used. This course concentrated on digital education theory and the use of web-based solutions, with lectures, lecture readings, exercises, seminars, and conferences by experts on digital competence, the Sámi language, and minority education, as well as distance education. The lecturers were from SUAS and the University of Lapland in Finland. Experts from Sámi Education Center in Inari, Finland, also held lectures and practices about digital and distance education in the Sámi language as they had extensive experience in those areas. The second half of the course included lectures on digital gaming and programming. The participants also attended a conference on digital gaming in Inari, Finland, in which professionals in digital game education gave lectures, and a practical session was organized. In addition, the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (DIKU) held a programming seminar for staff, student teachers, and practice school teachers. Lower secondary school students from Kautokeino also participated on the programming day to see the latest tools. There was a one-day laboratory in the lobby where new equipment could be tested.

During the first course, the Sámi digital education platform Digigiisá was used as a technical net-based education resource, and for learning how to use these kinds of platforms. The assignment for the course was a learning diary. A Google Forms online survey was used to collect participants' feedback on the course.

3.2 Course 2, Teaching and Learning Through Video Production

Course 2 was taught in spring 2018, and it was a massive open online course (MOOC) in English that focused on building the participants' capabilities in using video production as a teaching and learning tool. The course was designed and led by the University of Lapland in collaboration with SUAS, and it was offered also to University of Lapland students. The Moodle platform was used for the 6-week online course. The objective of the course was to promote students' digital competencies, media literacy, and cultural interaction. The participants (N = 15) were students from the University of Lapland International Media Education Master's Program, the University of Lapland Primary Teacher Training Program, the Sámi allaskuvla Teacher Training Program, Sámi allaskuvla teaching personnel, and practicing teachers from Koutokeino. The course was very multicultural, as there were participants from all over the world: Norway, the United States, Finland, Nigeria, and South Korea. During the course, the students engaged in online discussions and reflections about video production as pedagogy, read and viewed course materials, performed WebQuests, produced short videos, and viewed and commented on the videos produced by their fellow students. During the course, students also familiarized themselves with social media applications (specifically, Flipgrid and Padlet) suitable for producing, sharing and commenting on videos. As the final assignment, the students produced a short reflection video on the topic living in the

Arctic. Feedback for this course was gathered through the Moodle anonymous feedback tool and via email.

3.3 Course 3, Practical Development of Digital Education Competencies and Group Dynamics

Course 3 was taught in spring 2019, and it was held in English. The seven participants were teachers who use Sámi language for teaching from the primary school to university level. This course concentrated on the practical development of the participants' digital competencies in their own teaching contexts and on the development of collaborative teaching competencies with group dynamics workshops. These workshops included idea generation; learning from each other's ideas; how to do deep reflection, individually and in groups; how to give and receive feedback and communication; and how to promote collaboration. The participants in this course were teachers from different educational levels, from primary school to higher education, and had very diverse abilities in using technology to assist their pedagogical methods. Therefore, this course was designed to meet the needs of all participants so that they would get the necessary competencies in using digital tools in their teaching and learning activities.

During the course, the participants learned not only to use different digital tools but also to reflect on the chosen teaching tools' meaningfulness in the context of their own teaching. While choosing the teaching tool, and before planning to make their own teaching materials, the participants learned to consider critical factors, such as the subject of the learning and what they wanted students to accomplish. This meant that the teacher reflected upon, for example, if the objective required that students work in groups, learn a psychomotor skill, or enhance their abilities in using digital tools. Furthermore, the teacher reflected on the purpose of using the chosen digital tool or application. For example, was it for inspiring ideas, for providing guidance, or for visualizing something?

Additionally, the participants learned about the importance of evaluation and reflection throughout the learning process. Evaluating and reflecting on the usability of digital tools and materials can be performed by the teacher and the students. The digital tools that were used and evaluated in this course were divided into five sections. In the first section, the participants were introduced to Google Sites, and created a website for collecting all the course material that they were going to produce. In the remaining four sections, the students learned about all the tools. However, they had to choose an exercise with one or two tools to create their course material in each section. The participants were expected to justify their choices, evaluate the tools' meaningfulness for the particular purpose or topic of learning that they had chosen, and reflect on the whole process of learning the tool and teaching with the chosen tool. Feedback was collected in this course with a Google Forms anonymous online survey, and during the last session, reflections were collected from the participants.

4 Analysis and Findings

During the Focus on the North Project, the overall digital competency and the needs of SUAS personnel were also evaluated with an online survey. Teaching personnel highlighted the importance of getting technical knowledge in the future, and support to use different digital technologies. According to the results, further development work and supplementary courses are needed to keep personnel up to date with digital learning tools.

The project group gathered feedback at the end of each course. The Course 1 participants were pleased to gain knowledge in the pedagogy of digital learning and teaching, and exposure to tools, solutions, and the best ways in which to promote students' learning. They described many challenges to their competency, because some participants did not have any previous education in educational sciences or digital education. However, more and more programs at SUAS are conducted partly online, so teaching personnel need competency in how to organize teaching in a flexible way. Participants were very pleased to be exposed to many different aspects of digital education. At SUAS, the digital platform Sámi Digigiisá is now in use. Teaching personnel expressed that Digiisá is complicated for teachers and students. Therefore, education and guidance were organized for teaching personnel so that they had courses planned for their needs. Some participants were interested in learning more about various aspects, such as copyright issues associated with digital learning. Course 1 had 47 participants; however, only five turned in the final assignment for the course, which was a learning diary, and received credit for the course. This is because many participants did only some parts of Course 1.

Course 2 had 15 participants, of whom 11 passed; nine were students from the University of Lapland, and two were from SUAS (one faculty member and one student). In addition, four SUAS faculty members did parts of the online course. In their feedback, the participants praised the course contents and overall structure. In addition, the lecturer's effort to clarify all the details of the assignments and feedback on the questions and online activities were considered very clear. Participant 1 said:

I liked this course very much! I hate to hear my own voice, so this course was good for me, because now I had to listen to my own voice although I did not want to. I think the exercises were fun to do.

Participant 2 said, "The overall structure of the course was very well prepared, and it helped me a lot to just follow the instructions. Thank you for the lecturer's effort to clarify all the details of the assignment."

Some participants found some assignments demanding, as they had to read and understand difficult theoretical questions before they could start making the movie. However, other participants suggested harder exercises, as sometimes they seemed to be easy. The final assignment was a short reflection video which the students found quite demanding. Students also suggested that in the future they would be interested in participating in courses that combined synchronous and asynchronous distance learning methods. Course 2 was organized mainly asynchronously. Some students also wished to get editing assistance during their video-editing assignments.

In Course 3, the participants had diverse abilities with digital tools, meaning that some needed to create a Google account for the first time, but others were quite competent in using digital tools in their teaching and learning activities. However, the course objective was to give each participant more digital competencies that would suit their particular work requirements. When asked what was the main thing that they learned during this course, the participants together formed the core takeaway in the last reflection session: "We need to keep ourselves updated on digital teaching and learning tools, and think how I can use the tools with my students and learn to think differently when planning instruction." Teachers were aware of the need to continuously develop digital competencies as the field is changing all the time.

In the individual feedback, all the participants expressed how very relevant this course was for their work, even if some exercises were demanding. One participant stated that "it is important and useful for me as a teacher, a coordinator for minority languages, to follow the digital development. I have also experienced that collaboration and sharing is recommended for optimal achievement of learning the use of new digital tools." All participants agreed that they would use digital tools more in their teaching and learning in the future. The participants were also surprised at how important it is to learn how to give feedback, how to do reflection, and particularly how much more can be achieved by working together. One challenge of the course was that the participants' competency levels varied and tasks needed to be designed to fit everyones' learning needs. In addition, the course was organized in English, which was a new challenge for some participants. All seven participants passed the course and completed the assignments as required.

Regarding Sámi language challenges, improving teachers' digipedagogical competencies may have a long-lasting effect on developing Sámi education and Sámi people's learning. However, from all three courses some students expressed their frustration about the lack of time to do the assignments due to their own teaching, despite the fact that in many cases their employers had given them some extra time to earn credits in digital education. Producing learning materials for threatened languages, motivating Indigenous teacher's and pupils' lifelong learning, and promoting Indigenous languages' revitalization are key elements of what digital education can achieve.

5 Discussion and Conclusions

The Focus on the North-Digital Learning for Pre- and In-Service Teacher Education Project concentrated on Sámi language teaching and teaching in the Sámi language in Sámi teacher education at SUAS. SUAS personnel found the project very valuable for the extra resources this project offered to digital education in Sámi teacher education. The main focus was on enhancing competencies regarding teaching and learning with and through digital devices. Digitalization and its working methods involve holistic implementation to promote diversity and engagement in Indigenous education [18].

Organizational learning benefits the future work of SUAS, and the broad competencies acquired in digital learning are evident. Many of the SUAS teaching staff, student teachers, and practice school teachers participated in different courses during the project. The project provided substantial resources to develop digital education on a daily basis, and helped resolve many challenges faced in teacher education. Knowledge about possibilities of digital education increased, and at the organizational level, individuals were convinced about the effort and personnel capabilities needed to strengthen digital education in Sámi teacher education [10].

Many different ways of organizing the courses of this project's program gave participants new insights into how to organize digital education. For example, a learning diary was a completely new method for some of the participants, so hopefully, they will now be able to organize these tasks for their students. Participants did not know how to write a learning diary, so the Course 1 teacher also provided instruction in that.

Overall, the participants' experience regarding the digital education courses was positive. Almost all the teachers agreed to learn about and practice new digital tools in the future, and keep up to date with the new educational technology. This was realized especially during the third course when certain technologies did not work the way the participants knew they had worked in the past. Digital tools used for teaching ranged from easy to difficult. Due to the participants' varied competencies, some found the technologies easy and some very difficult. It was in the case of difficult technologies, such as editing video software, that many participants agreed that they needed some assistance. However, overall, the response to using such technologies was positive. Furthermore, the participants agreed that it is very important to share their knowledge with other teachers. Many teachers found it surprising that through reflection and feedback their knowledge grew tremendously. Therefore, many teachers acknowledged that they would use a workshop design with their students to help them learn.

Limitations and critical reflections touched on the fact that a limited number of people participated in different sections. Therefore, we cannot generalize competence development prospects. Furthermore, teachers' commitment to updating their digital competencies may vary due to lack of time and interest. Efforts to motivate student teachers, teacher education personnel, and practice school teachers to enhance their competency in digital education are important, as there are unlimited possibilities when working with digital education and Indigenous languages. More research must be conducted, as knowledge about Indigenous languages digital education is scarce.

The SUAS Sámi allaskuvla is very grateful as the Norgesuniversitet funding made it possible to promote digital learning at SUAS at an impressive level in the Sámi language context. The course introduced many new aspects and ways to promote the Sámi language now and in the future.

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The Relationship Between Academic Stress and Health Status—The Moderating Role of Social Support

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Abstract. The purpose of the study was to explore the direct effects of vocational students' study stress and social support on physical and mental health as well as to evaluate the moderating role of social support between study stress and physical and mental health. Data was collected from 232 vocational Data Processing Department students in Taiwan and was analyzed using hierarchical regression. The results show that vocational students' study stress had a negative effect on physical and mental health, and parental support had positive influences on physical and mental health. In addition to the direct effect, partial support for teachers' support can reduce the negative impact of academic stress on physical health. Partial support for classmate support can reduce the negative impact of academic stress on mental and physical health. Through these empirical findings, practical implications and suggestions for further research were discussed.

Keywords: Academic stress · Social support · Physical and mental health

1 Introduction

Under the influence of higher education and traditional culture, students in Taiwan bear a heavy pressure of learning. According to the Health League Foundation [1] survey, 47.8% of students had an average of more than four days a week to take the test, 50.4% felt fatigued and 49.6% slept less than seven hours at night. As they get older, students feel more helpless and confused about their learning. When students encounter their limitations to solve the troubles or pressures, they often feel shy, helpless, and this even affects physical or psychological growth. Due to students' limited self-awareness, stress response skills and problem-solving skills are not yet mature, so when stress is formed, inappropriate response patterns may develop. The stress can be due to too much homework, poor academic performance, preparation for exams, lack of interest in a profession or discipline, and academic-related punishments.

How can we help students find the right way to face and relieve this huge stress? Social support may play an important role. It will be very important for students to get the support of parents, teachers, and classmates. This study explores the relationship

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 685–694, 2019.
https://doi.org/10.1007/978-3-030-35343-8_72

between academic stress and physical and mental health, and further understands the impact of parents, teachers and classmates' support on them (see Fig. 1).

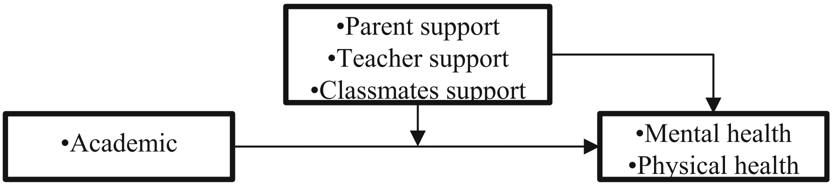

Fig. 1. Research framework.

2 Literature Review

2.1 Academic Stress

Stress is the body's reaction to any change that requires an adjustment or response. The body reacts to these changes with physical, mental, and emotional responses. Stress is a normal part of life [2]. When human beings bear psychological and physical stimuli, they will produce a state of tension, anxiety, and stress when they exceed a certain limit [3]. Furthermore, Most of the academic stress is due to students' perceptions of students' academic achievement. Stressors related to test anxiety are such as worrying about taking tests, test preparation, receiving poor grades, failing an exam, and failing marks at school [4].

Therefore, any stress caused by learning-related factors can be called academic stress. Too high learning pressure will affect students' physiology, psychology and behavior, resulting in tension, anxiety, anxiety and other negative effects of physical and mental health. The academic stress defined in this study are exams, learning difficulties, and homework loading.

2.2 Physical and Mental Health

The World Health Organization defines health as a state of total physical, psychological, and social well-being, so health includes a personal physical, psychological and social dimension [5]. According to studies, many physical and mental illnesses are associated with stress [6]. The state of physical and psychological fitness of the individual is the state of health, and the body and mind are inseparable from each other.

2.3 Social Support

Social support is the assistance an individual can receive from his or her network or social support [7]. Increased social support can reduce mental stress, improve personal physical and mental health, and reduce the negative impact of stress on individuals. Cooper, Dewe, and O'Driscoll [8] point out that when an individual is faced with a stressor, the absence of social support will cause individuals to have a variety of negative reactions; in contrast, if an individual can obtain social support, the negative effects of stress will be greatly reduced.

Different sources of social support have different effects on individuals, and individuals need different types of support because of their situations [9]. Students' social networks often interact with parents, teachers, and classmates, so social support related to students in three categories: parental support, teachers' support, and Classmates' support.

2.4 Effects of Academic Stress on Physical and Mental Health

In empirical studies on the correlation between academic stress and physical and mental health, some scholars used physical and mental health as a model and found that academic stress was negatively correlated with physical and mental health [10]. That is, the greater the stress of individual learning, the more physical or psychological symptoms. In other words, the pressure of schoolwork has a direct impact on the learning process of students, in the school performance of continuous failure, frustration will make students feel self-esteem damage, despair, deny self-worth and feel the pressure, further affect students' physical and mental health, that is, the greater the pressure of learning, the worse physical and mental health.

Therefore, this study on the relationship between students' learning pressure and physical and mental health, put forward the following assumptions:

H1: Academic stress had a negative effect on mental and physical health.

H1a: Academic stress had a negative effect on mental health.

H1b: Academic stress had a negative effect on physical health.

2.5 Effects of Social Support on Physical and Mental Health

Cohen and colleagues [11] refer to social support as "any process through which social relationships might promote health and well-being". In many studies supported by society, a positive correlation between it and physical and mental health has been found [12, 13].

This study suggests that when vocational students experience high academic stress, it may reduce the negative impact of academic stress if they receive timely social support from parents, teachers or peers. Therefore, this study puts forward the following hypotheses for the relationship between social support and physical and mental health of vocational students:

H2: Parental support had positive influences on mental and physical health.
H3: Teachers' support had positive influences on mental and physical health.
H4: Classmates' support had positive influences on mental and physical health.

2.6 The Moderating Role of Social Support

Parental and teachers' support can reduce the negative impact of academic stress on physical and mental health. When parents and teachers find that students are stressed due to learning, if they can provide emotional and learning assistance in real-time, we can reduce the physical and psychological wear and tear of students, and also enable students to reduce the physical and mental discomfort caused by stress, and in the daily environment, through the regulation of support, can also buffer the adverse effects of stress. And support from peers, but also for individual learning pressure, produce a buffer ingress. When students feel that peer members communicate well with each other, provide Classmates' support, and build trust in their peers, they have a more positive psychological state and behavior, and can also reduce the negative effects of academic stress. Therefore, this study, in view of the regulatory effects of social support, puts forward the following assumptions:

H5: Parental support can moderate the negative impact of academic stress on mental and physical health.
H6: Teachers' support can moderate the negative impact of academic stress on mental and physical health.
H7: Classmates' support can moderate the negative impact of academic stress on mental and physical health.

3 Method

3.1 Participants and Procedures

The study participants were divided into pre-test and formal two stages.

1. Pilot test: 87 students in the Night Data Processing Department of a vocational school in Taiwan. Of these, 49 women and 38 men.
2. Formal test: 232 students in the Day Data Processing of a vocational school in Taiwan. Of these, 124 women and 108 men.

3.2 Research Instrument

This study used questionnaires to examine the relationship between academic stress, physical and mental health and social support. In the design of the questionnaire question items, in addition to some of the basic personal data of the question items, the other measures are on the Likert five-point scale, asking the respondents for the degree of consent to the question item (Table 1).

The "Social Support Scale" has 13 items. The results of the reliability analysis show that its Cronbach's alpha (internal consistency coefficient) is .904, with acceptable reliability. The results of the EFA analysis show that KMO = .86, χ^2 = 777.194 (df = 78, p < .001), that it is appropriate to factor analysis. Based on the component analysis method (eigenvalue > 1) and varimax orthogonal rotation, extract 3 factors (parental support, **PS**; teachers' support, **TS**; classmate support, **CS**), the cumulative interpretation variation is 74.08%.

The "Academic Stress Scale" has 10 items original. The reliability analysis deletes 1 item. Results show that Cronbach's alpha is .856; with acceptable reliability. The results of the EFA analysis show that KMO = .72, χ^2 = 135.4335 (df = 6, p < .001), that it is suitable to factor analysis. Based on the component analysis method (eigenvalue > 1) and orthogonal rotation, extract 3 factors (homework stress, **HS**; learning stress, **LS**、examination stress, **ES**), the cumulative interpretation variation is 79.08%.

The "Health Scale" has 8 items. The results of the reliability analysis show that its Cronbach's alpha (internal consistency coefficient) is .896, with acceptable reliability. The results of the EFA analysis show that KMO = .87, $\chi^2 = 448.031$ ($df = 28$, $p < .001$), that it is appropriate to factor analysis. Based on the component analysis method (eigenvalue > 1) and orthogonal rotation, extract 2 factors (mental health, **MH**, negative emotion; physical health, **PH**), the cumulative interpretation variation is 75.62%.

3.3 Data Analysis

This study used hierarchical regression to analyze the direct effects of learning stress, social support, Classmates' support on mental and physical health, and to examine the regulatory role of parental support, social support and Classmates' support in the relationship between work stress and physical and mental health.

Table 1. Internal consistency & EFA factor loading.

Factor	Item	Cronbach's alpha		EFA factor loading
PS	4	.863	.904	.739 .878 .822 .697
TS	5	.905		.730 .880 .843 .800 .560
CS	4	.868		.742 .794 .870 .852
HS	4	.875	.856	.800 .790 .822 .845
LS	3	.852		.820 .837 .878
ES	2	.876		.929 .906
MH	4	.816	.896	.797 .773 .876 .764
PH	4	.901		.882 .895 .869 .873

4 Results

4.1 Model Tests and Simple Slopes Tests

According to Table 2, first, four control variables, grade, gender, work status, and weekly homework time situation, were placed in the regression program of each model, and it was found that the betas of each model were not significant.

In **Model 1A** & **Model 1B:** when AS is placed in the regression program, $\beta = -.45$ ($\Delta R^2 = .20$, $p < .001$) and $\beta = -.31$ ($\Delta R^2 = .10$, $p < .001$), shows that academic stress has a significant negative impact on mental and physical health. That is, when the higher the academic stress perceived by the vocational students, the worse their mental and physical health. Therefore, hypothesis **H1** is supported.

Also, when PS is placed in regression program, β = .14 (ΔR^2 = .20, p = .019) & β = .19 (ΔR^2 = .03, p = .003), shows that parental support has a significant positive effect on mental and physical health. That is, parental support is helpful to the mental and physical health of vocational students. Therefore, hypothesis **H2** is supported.

Finally, when AS-PS interaction terms are placed in regression, β=−.03 (ΔR^2 = .00, p = .644) & β = −.02 (ΔR^2 = .00, p = .735), not significant. It shows that parental support has no moderation effect on the relationship between academic stress and mental-physical health. Therefore, hypothesis **H5** is not supported.

In **Model 2A** and **Model 2B**, when TS is placed in regression program, β = .10 (ΔR^2 = .01, p = .129) & β = .05 (ΔR^2 = .00, p = .444), shows that teachers' support has no significant positive effect on mental and physical health. Therefore, hypothesis **H3** is not supported.

Besides, when AS-TS interaction terms are placed in regression, β=−.07 (ΔR^2 = .01, p = .257), not significant; and β = −.21 (ΔR^2 = .04, p = .002), significant. Showing that parental support has a moderation effect on the relationship between academic stress and physical health, but has no effect on the relationship between academic stress and mental health. To further test the teachers' support for the regulation of academic stress and mental health, this study refers to the recommendations of Aiken, West & Reno [14], drawing the interaction status of Fig. 2.

Here, simple slopes analysis revealed a negative relationship between academic stress on physical health for students perceived teachers' support high (B = −357, p < .001, significant), whereas there was no relationship between these constructs for those who were perceived teachers' support low (B = −.133, p = .061, not significant).

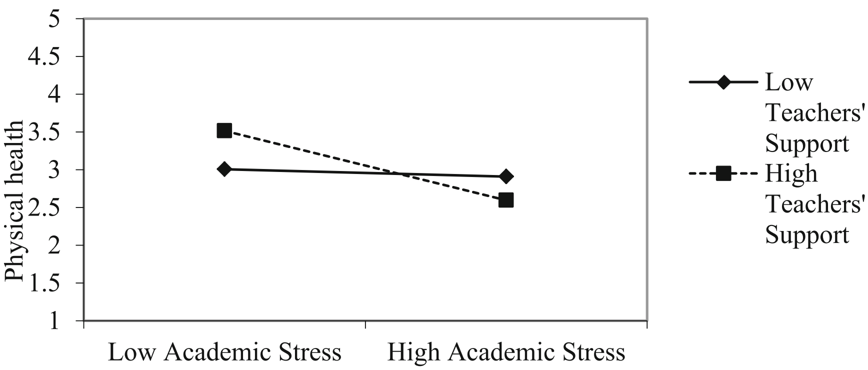

Fig. 2. The interaction between academic stress and teachers' support on physical health.

High teachers' support has a higher slope than low teachers' support, which shows that teachers' support improves physical health, but for those with low academic stress, teachers' support is more effective at improving physical health. When academic stress increases, teachers' support has less buffer effect on the negative effects of academic stress on physical health. It shows that for students with low academic stress, teachers' support is beneficial to improving physical health, however, for those with high

Table 2. Direct effect & moderation analysis[a].

Variables	Model 1A MH	Model 1B PH	Model 2A MH	Model 2B PH	Model 3A MH	Model 3B PH
D_Grade 1	−.01	−.06	−.01	−.06	−.01	−.06
D_Grade 2	−.02	−.06	−.02	−.06	−.02	−.06
D_Girl	−.11	−.06	−.11	−.06	−.11	−.06
D_part time job	−.03	−.13	−.03	−.13	−.03	−.13
D_HW 0-4 h/week	.06	.07	.06	.07	.06	.07
D_HW 5-8 h/week	−.01	.04	−.01	.04	−.01	.04
D_HW 9-12 h/week	.04	−.02	.04	−.02	.04	−.02
ΔR^2	(.02)	(.03)	(.02)	(.03)	(.02)	(.03)
$Z_{\text{Academic stress}}$	−.44***	−.31***	−.44***	−.31***	−.44***	−.31***
ΔR^2	(.20)***	(.10)***	(.20)***	(.10)***	(.20)***	(.10)***
$Z_{\text{Parental support}}$	.14*	.19**				
ΔR^2	(.20)*	(.03)**				
Z_{AS}*Z_{PS}	−.03	−.02				
ΔR^2	(.00)	(.00)				
$Z_{\text{Teachers' support}}$			.10	.05		
ΔR^2			(.01)	(.00)		
Z_{AS}*Z_{TS}			−.07	−.21**		
ΔR^2			(.01)	(.04)**		
$Z_{\text{Classmate support}}$					.07	.03
ΔR^2					(.00)	(.00)
Z_{AS}*Z_{CS}					−.25***	−.18**
ΔR^2					(.04)**	(.03)**
Total R^2	.23	.16	.22	.16	.26	.16
Adjusted R^2	.19	.12	.18	.13	.22	.12
F value	6.46***	4.18***	6.20***	4.33***	7.64***	4.07***
Degree of freedom	10, 221	10, 221	10, 221	10, 221	10, 221	10, 221

[a]$N = 232$, *$p < .05$, **$p < .01$, ***$p < .001$; Homework, HW; Academic stress, AS; Parental support, PS; Classmates' support, PS; Mental health, MH; Physical health, PH.

academic stress, we need to know more about the nature of academic stress and the level of interference. Therefore, **H6** is partially supported.

In **Model 3A** and **Model 3B**, when CS is placed in regression program, $\beta = .07$ ($\Delta R^2 = .00, p = .151$) & $\beta = .03$ ($\Delta R^2 = .00, p = .488$), shows that classmates' support has no significant positive effect on mental and physical health. Therefore, hypothesis **H4** is not supported.

Also, when AS-CS interaction terms are placed in regression, $\beta = -.25$ ($\Delta R^2 = .04$, $p < .001$) and $\beta = -.18$ ($\Delta R^2 = .03$, $p = .005$), significant. Showing that classmates' support has a moderation effect on the negative relationship between academic stress and mental health. In other words, students support the negative relationship between academic stress and mental and physical health, which will have a slowing adjustment effect. To further test the classmates' support for the regulation of academic stress and mental-physical health, drawing the interaction status of Figs. 3 and 4.

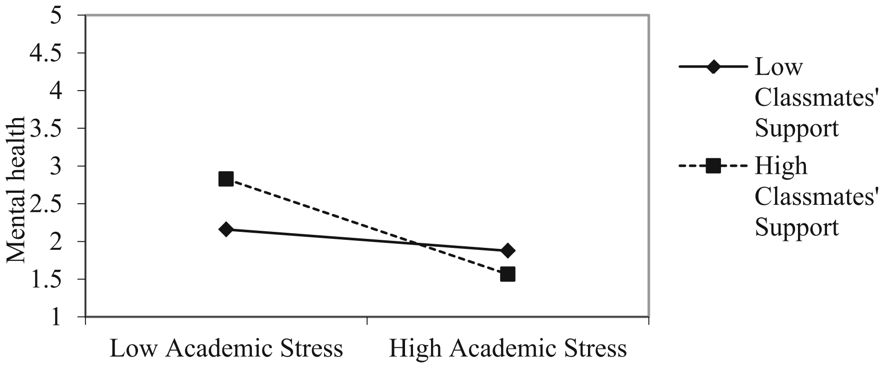

Fig. 3. The interaction between academic stress and classmates' support on mental health.

Simple slopes analysis revealed a negative relationship between academic stress on physical health for students perceived classmate support high ($B = -.463$, $p < .001$, significant), whereas there was no relationship between these constructs for those who were perceived classmates' support low ($B = -.165$, $p = .011$, significant).

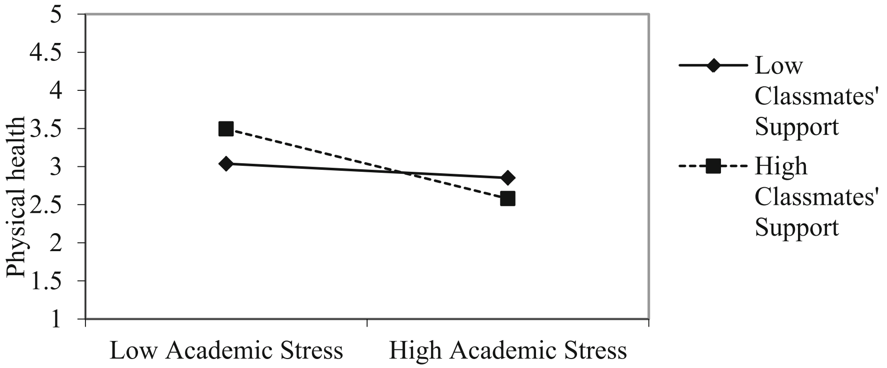

Fig. 4. The interaction between academic stress and classmates' support on physical health.

Simple slopes analysis revealed a negative relationship between academic stress on physical health for students perceived classmate support high ($B = -.397$, $p < .001$, significant), whereas there was no relationship between these constructs for those who were perceived classmates' support low ($B = -.134$, $p = .105$, not significant).

Comprehensive Figs. 3 and 4, high classmate support has a higher slope than low teachers' support, which shows that classmate support improves mental-physical health, but for those with low academic stress, classmate support is more effective at improving mental-physical health. When academic stress increases, classmate support has less buffer effect on the negative effects of academic stress on mental-physical health. It shows that for students with low academic stress, classmate support is beneficial to improving mental-physical health, however, for those with high academic stress, we need to know more about the nature of academic stress and the level of interference that classmate support sits on mental-physical health. So, **H7** is partially supported.

5 Discussion and Conclusion

To explore the relationship between academic stress and mental-physical health of vocational students. The empirical results of this study support the hypothesis that academic stress has a negative influence on mental and physical health, that is to say, vocational students' poor physical and mental health is related to high academic stress. Vocation students need more attention in their study life on campus.

To explore the relationship between parental support and mental-physical health of vocational students. The empirical results of this study support the hypothesis that parental support positive effects on mental and physical health, that is, the higher the level of parental support, vocational students' physical and mental health will be better.

To explore the influence of teachers' support on the relationship between academic stress and mental health. The empirical results of this study partially support the hypothesis that teachers' support can reduce the negative effects of learning stress on physical health. It is worth noting that teachers in the campus, in addition to the external performance of students, but also need to pay attention to the internal psychological health of students. Teacher's excessive concern may cause students more mental stress.

Likewise, this study partially supports the hypothesis that peer support can reduce the negative impact of academic stress on mental-physical health. The development of students' self-concepts will be influenced by the expectations of others. Excessive expectations will increase self-esteem and pay more attention to academic performance. Further, the tension, stress, and anxiety during the learning process have a negative impact on physical and mental health. Teachers and students should adjust their support and care appropriately and don't overdo it.

6 Limitations and Future Direction

Our research had the following limitations. First, our research was a limited to specific high student group and the result may not apply to other populations. Second, academic stress only includes learning stress, exam stress, homework stress, no included environmental stress, interpersonal relationships, and other factors. Future studies could be considered for inclusion to make the study more sustainable.

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A Teacher's Reflection of a PBL-Based Curriculum

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Abstract. This research is an action research about reflecting of instruction. The "teacher's goal" of the course is to cultivates their self-learning and problem-solving abilities through the process of finishing a personal project - developing games. After eighteen-week courses, students will generate game works. However, the instruction evaluation from students is not on the same page. Based on investigative results of instruction evaluation, students who have participated in the courses were interviewed after semester end, and instructors' further reflection will be brought up from interview results.

Keywords: Project-based learning · Problem-based learning · Instruction evaluation · Interview · Communicative action

1 Introduction

Most of the current multimedia introduction course instructions mainly focus on "theoretical concepts, multimedia application methods", supplemented by multimedia tools and platforms practicing. The teaching mode is based on technical training, lacking high-level thinking training; in learning materials, millennials are quite familiar with multimedia, and game-related learning materials. This study takes game-based multimedia as the main axis and adopts PBL (project-oriented and problem-oriented learning) mode to guide students to learn, and further discussing the feedback from students and interview results as reflections about the instruction.

2 Literature Review

2.1 Game Development Project

Research on the introduction of game development into multimedia courses shows that students' learning motivation (including intrinsic goal orientation, task value, learning control beliefs and self-efficacy of learning and performance), as well as learning strategies, time management and has been a significant increase in self-assessment. Past

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 695–702, 2019.
https://doi.org/10.1007/978-3-030-35343-8_73

empirical research has pointed out that programmatic courses aiming at game development have a significant positive impact on the effectiveness of social interaction learning. Among the various game types, AR and VR type games can best provide a lively and interesting learning environment, which is most popular among current emerging science and technology curriculum developers.

2.2 PBL Model

Project-based learning is based on a constructivist view. Learning is a process of "constructing" knowledge in a social environment, rather than a process in which the traditional learning process considers learning to be "acquiring" knowledge. Project-based learning refers to instruction that deals practical issues as the core, and encourages students to discuss, and cultivate students' active learning, critical thinking and problem solving skills. Project-based learning can be applied to teaching in various fields. Jacobs and his team integrated the project learning orientation into the business school executive education and proposed a project-based EE model [1]; Genc implemented project-based learning in its environment, in which students are guided to think about and solve local environmental problems [2].

The problem-oriented learning method similar to the thematic learning spirit includes three stages: (1) problem development; (2) initiation of PBL events, inquiry, and investigation; and (3) Problem solution [3]. Barrows trained medical school students with problem-oriented learning, found that PBL has a significant effect on developing students' practical problem-solving skills [4]. Professors at Stanford University applied the PBL approach to executive training, which helped the professional development of executives [5]. In other words, problem-oriented learning allows students to form real-life problems in real-world situations, and to discuss problems through common discussion and raise the motivation for learning.

In sum, the purpose of this study is fourfold: 1. Understand the problems faced by students in thematic learning; 2. Exploring the difficulties and improvement strategies faced by teachers in the course of activities; 3. Suggesting practical applications for PBL teaching.

3 Method

This study adopts action research. After the development of the curriculum and implementation of the teaching, the researchers review the teaching evaluation (see Table 1 below), and through interviews, to understand the students' specific views on the course, in order to improve the follow-up course. The course design, teaching assessment results, interviewees and interview structure of this study are described below.

Table 1. Results of the teaching evaluation of the multimedia integration course (for the average number of people, dimension average score)

Dimension (3 items each)	Average persons					Average scores
	Strongly agree (5 points)	Agree (4 points)	Medium (3 points)	Disagree (2 points)	Very disagree (1 points)	
Teaching attitude	14	13	8	1.6	2.3	3.89
Teaching methods	12	15	7.3	1.3	3.3	3.79
Teaching content	12	14.7	7.7	2.3	2.3	3.81
Assignment	14	15	8	1.3	0.7	4.03
						3.88
Qualitative feedback	* Positive: The teacher is earnest and has learned a lot!! * Neutral and negative: 1. In fact, the industry teacher is better 2. The homework is too hard, and the teacher should be concerned that the student still has other course pressures 3. The multimedia integration system's curriculum unreal game production, feeling can be opened in elective courses, rather than forcing everyone to learn in compulsory (and not everyone's computer can be high-profile to support game production, need to consider the student economy problem)					

4 Curriculum Development

This study teaches the tool Epic Unreal 4 game engine and is aimed at developing 3D games. The content introduces the relevant cases of game development in multimedia integration, the application range of multimedia elements and multimedia elements in game design, and game display.

In the practical operation course, teacher's computer screen and the teacher's oral interpretation content are recorded. Those videos will upload to the online learning platform for students to review (eLearning). The assignments during class allow students to practice what they have learned. Teaching assistants (TA) are arranged to guide students' homework each week after class. In terms of learning and communication, we also set up a community platform for the FB community website, sharing teaching materials and teaching materials and eLearning textbooks and published works. In the course, students are grouped by the concept of PBL project-based learning, students went through the generating project theme, decision-makin, project evaluation criteria, cross-disciplinary learning to product a game and complete the game project development.

5 Teaching Evaluation Result

After the end of the semester (19th week), the instructor will obtain the results and opinions of the students in the class. The average score of this course is the lowest of the semester among the teachers lecturing courses (the first semester of the 107th year). The teacher's average score is 4.35 points.

6 Interviewee

At the end of the semester, the study randomly selected three students (32 students in the class, gender ratio, two girls, one male student) to conduct qualitative interviews. The respondents' answers are recorded, and the interview content will be sorted and converted. The verbatim draft is recorded every detail of the interview.

6.1 Interview Structure

In this study, the semi-structured interview questionnaire was used to record and convert the interview content into a verbatim draft using live recording and text recording. The following is the interview structure, which includes two aspects of learning process and teaching content.

- Learning process

  1. In the past semester of study, did you feel that you have made progress? In what ways?
  2. In the past semester of study, what kind of teaching method did you get the most out of teaching?
  3. What do you think is interesting and difficult in this course? why?

- Teaching content

  4. What is the difference between the teaching method of the division and the teaching method of the instructor?
  5. What difference do you think the textbooks prepared by the divisions and the teaching materials of the instructors?
  6. In the past semester of study, what is the biggest benefit for you in the collaborative teaching curriculum?

7 Results and Conclusions

7.1 Interpretation of Teaching Evaluation

In the four dimensions, the teaching methods have the lowest scores, and the average number of students who choose strongly disagree with teacher's teaching method (3 items) is 3.3. The average course score is 3.88, which is lower than the average of 4.42 for the overall course and is also lower than 4.50 which is whole school courses' average score. Compare to the lecture's other course evaluation scores, in this course, more students do not agree with the teaching method of the course.

7.2 Interview Results

After the coding and collection of interview data, this study summarizes the following conclusions, in order to provide suggestions for the future development of innovative curriculum development scholars, divided into external control factors and internal control factors:

1. External control factors: insufficient teaching equipment in schools

If a worker wants to do something good, he must first sharpen his tools. Students think that the project works are very memory-consuming and the computer classroom is not enough. I hope that the school can provide sufficient teaching equipment and learning space so that students can actually use it to improve students' willingness to learn and learn. Results.

(S1) There is not much space and time to be implemented. It is recommended that schools provide sufficient learning space.
(S2) I have eaten the memory of the computer before I started to do it. I ran off when I ran and felt very sad.
(S3) It is recommended that this course can be changed to an elective. The equipment of each classmate's home is not so adequate.

2. External control factors: compulsory or elective?

Students subjectively believe that this course should be elective course (S2, S3), so that students who are really interested in electives to improve students' willingness to learn and improve their learning outcomes.

(S2) The course of multimedia integration system Unreal game production, it is recommended to open in elective courses, and not everyone's computer can be high-profile to support game production, and students' economic problems need to be considered.
(S3) The content of the course is quite rich. It is suggested that this course can be changed to elective. The course is compulsory. The students' ability, time, economic environment and future needs are not considered. The hard arrangement is not provided but sufficient hardware equipment is provided to assist the teaching.

3. Internal control factors: the industrial teacher improves learning motivation

In the course, the industrial teacher can share workplace experience with students and improve students' motivation. Let students who love the multimedia integration system generate a high degree of interest in learning, and strengthen the link between industry and academia, and cultivate students' employment competitiveness and practical ability.

(S1) The practitioners practiced and talked about the theory, and they can learn the professional knowledge that the school did not teach. The teacher's collaborative teaching has benefited me a lot.

(S2) This collaboration with the industry can help us understand the professional skills in the workplace. The teacher is teaching the software how to operate, the division will teach how to achieve this function, will explain how this happens, and how to operate.
(S3) Like the original thing, the character has only basic movements, the teacher did not teach, and spent two days studying the movement of rubbish, feeling very fulfilling.

4. Internal control factors: knowledge center or student center?

The students suggest that the course must pay attention to the students' learning situation. The teacher's teaching plan must flexibly adjust the teaching content, progress and evaluation methods according to the student's learning progress, effectively guide the students to achieve the teaching goals, and improve the students' motivation and effect.

(S1) The teacher is very serious and learns a lot of things, but the homework is too hard. The teacher should worry that the students still have other academic pressures. In addition, the film content and teaching content prepared by the teacher may have different ways. Other students do not know that they may think it is wrong, and there is no way to solve the bug.
(S2) The teacher will give you a goal and will teach you how to do it. In order to reach him, there will be more goals.
(S3) The teacher has noticed the degree of absorption of the classmates, and the schedule is also on schedule, but the response rate to the students is not so fast.

8 Conclusions and Discussion: Student Center or Competency Center

Overall, the instructor differed between the course expectations and student expectations. Teachers are assessed to develop students' problem-solving skills, technical skills, and teamwork skills, and adopt innovative and "ideal" teaching models; however, students are listed as uncontrollable factors for the hardware equipment required for the course, and for others. The course emphasizes the burden and affects its evaluation of the course. In addition, the course is collaborative teaching. There are differences in teaching styles and pace which leads to different evaluations of teaching. Among them, students are more convinced that the teacher from industry do integrate the theory with practical experience.

In terms of curriculum system, students regarded that heavy courses should be elective courses in order to respect students' choices. This indicates the difference between teachers and students' expectations, that is, the difference between knowledge, competence center and student center. The design of this course is based on knowledge. The design of the course is competence-centered. Therefore, to respond to the needs of students and is not the primary purpose of the course.

In the future, in the development of innovative courses for PBL, this study proposes several recommendations:

1. Investigation to understand the availability of students for hardware resources, measure whether to increase the supply of equipment resources, reduce the burden on students
2. Through pre-class communication, in order to achieve the balance between student needs and curriculum objectives: This course is different from other courses in the Information Management department, which indicates the necessary of communication between teacher and students.
3. More exquisite curriculum design: The study course adopts project-based learning. It is true that students successfully develop project works at the end of the semester. However, in the detailed teaching operation, the course teachers follow the steps of project-based learning. However, it did not follow the spirit of project-based learning in a more detailed teaching process. For example: According to Larmer and Mergendoller [6], project learning includes seven core concepts (a) A need to know: why do this project, (b) drive students' questions (A driving question): Ask students questions or goals, (c) Student voice and choice: Key factors, students feel the meaning of the project, (d) 21st century skills: 5C capabilities, the ability to use technology, (e) Inquiry and innovation: true inquiry leads to innovation, and (f) feedback and revision: enhance peer-to-peer quality by promoting peer-to-peer evaluation (e) A publicly presented product: Showcase works in front of peers, parents, community representatives, entrepreneurs, and even government officials. The implementation of the curriculum of this study does neglect the need and the key factors of the student's voice and choice, so that many students do not think that what they have learned is important and needed, even if they complete the work under the responsibility of responsibility. And feel that it is a waste of time and a lot of resentment.
4. Teaching Professional Development, Student Rights and Character Opportunity Education: The introduction of teaching assessment mechanism in colleges and universities is intended to improve the teaching effectiveness of teachers through student feedback. Students then regard teaching evaluation as an anonymous channel of their own voice. However, under this wave of attention to student needs, is teaching becoming a consumer-oriented commodity? The rational feedback of students helps the teacher to adjust, but the irrational critique reflects the excessive student center and neglects the basic etiquette of mutual respect. According to this, in a high-educational atmosphere that emphasizes professional ability improvement, character is still a topic that cannot be ignored by a hundred-year-old tree, and it is necessary to provide a character education that is deaf and eye-catching from the school environment.
5. Teachers should improve their communication skills: According to the above, this study believes that modern teachers need to lead by example, starting with moderate respect for students and engaging in more communication and dialogue with students; according to the spirit of Habermas's theory of communication action, Attempts to achieve understanding and consensus through rational communication constructed through communication actions and rational discussions.

Acknowledgement. This study is grateful to the Ministry of Education for its teaching practice program, the subsidy for the National Science and Technology College of the Ministry of Education and the Ministry of Science and Technology of the Republic of China for financially supporting this research under Contract MOST 108-2628-H-025-001-MY3.

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Design and Development of Interactive Learning Environment Model to Enhance the Creative Problem Solving Thinking for Computer Education Students

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Abstract. This study was aimed at designing and developing the interactive learning environment to enhance creative thinking in problem solving for computer education students. The Developmental Research Method - Type II of Richey and Klein (2007) was used with focuses on a model design and development. During the first phase, the model was designed and developed through the following steps: (1) studying relevant principles, theories and research, (2) synthesizing the theoretical framework, (3) studying the context, (4) synthesizing the designing framework, (5) developing the interactive learning environment, (6) assessing the efficiency of the interactive learning environment, and (7) studying the real context of the interactive learning environment. The findings of this phase show the following major components of the interactive learning environment, namely, (1) problem base, (2) learning resource, (3) related case, (4) cognitive tool, (5) training for creative problem solving thinking, (6) collaboration, (7) scaffolding, (8) coaching, and (9) stakeholders. In terms of the efficiency of the interactive learning environment model, we found efficiency in the experts' evaluation, in learners' attitudes, in creative problem solving thinking, and in learning achievements.

Keywords: Interactive learning environment · Creative problem solving thinking · Constructivist

1 Introduction

The thinking that covers the necessary process and skills for the 21st Century is the creative problem-solving thinking. The thinking processes that enable the design and development of various new concepts consist of 'Convergent Thinking', which relies on former knowledge and experiences and 'Divergent Thinking', which refers to creative thinking including fluent thinking, initiative thinking, flexible thinking, and elaborate thinking, all of which mutually and appropriately supporting one another before being creatively modified for problem solving [3]. It can be seen that the process of complex problem solving requires advanced thinking, i.e., both convergent thinking and divergent thinking should be applied harmoniously in order to lead to success. Before learners can solve any problem, they would use convergent thinking to

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 703–712, 2019.
https://doi.org/10.1007/978-3-030-35343-8_74

construct various concepts. This thinking spreads out aspects; it is free thinking beyond any rules and without logics or principles but would lead to the best answer. They can use divergent thinking, which means analyzing based on logics and principles in order to acquire the best answer. The study by Guilford concludes that there are two major thinking behaviors. One is convergent thinking which is one-way thinking and is a narrow problem solving process. There are few alternatives that lead to the best way to solve the problem which is selected from the environment surrounding that problem. It is referred to as critical thinking which requires a wide range of reasoning. The other major thinking behavior is divergent thinking, which is the brain process enabling thinking in various aspects and various directions in order to find unlimited numbers of answers, leading to new and uncommon idea from the set stimulant. Thinking can be in various directions and relies on imagination, intuition, intention, and is referred to as creative thinking. Thus, for problem solving in the 21st Century, creative thinking and critical thinking are very important. The two thinking processes must harmoniously interrelate, and problem solving will be successful or not depends on the use of these two skills, not only one of the two [4].

From the above reasons, the researcher designed and developed the interactive learning environment to enhance creative problem-solving thinking for computer education students. The results of the study on the efficiency of the learning environment model developed in Phase 2 indicated that the learning environment model is efficient. Hence, the researchers used the learning environment model in the study of the creative problem solving thinking of the learners. The research question is the interactive learning environment can enhances the creative problem solving thinking for computer education students.

2 Research Objectives

To design and develop the interactive learning environment that enhances the creative problem solving thinking for computer education students.

3 Research Scopes

3.1 Target Groups

The target group was divided into 2 large sub-groups. The first consisted of experts in different fields to validate the model's quality, namely 3 experts to investigate the content validity, 3 experts in instructional design to investigate the learning environment design quality, 3 media experts to investigate web-based media, and 2 evaluation and assessment experts to investigate the instrument qualities. The second group was composed of 20 s year computer education undergraduate students who registered the course 237111 Computer Language for Education during the first semester of 2014 at Khon Kaen University.

3.2 Research Design

This study was based on the Developmental Research, Type II [5] which focused on the design and development of a model. The research was performed in 3 phases, namely, (1) model development, (2) model validation, and (3) model use. The learning environment design was conducted in Phase 1, model development, with an aim to design and develop the model. The process comprised documentary research, study of instructional context, synthesis of model design framework, model design to construct the learning environment, and quality improvement. Those involved in the model development phase included theorists, designers, developers, evaluators, researchers and learners.

3.3 Research Tools

Experimental instrument – The instrument used was the learning environment model developed through the following process: (1) study of the principles and theories, (2) study of the context, (3) synthesis of the model design conceptual framework, (4) design and development of the model, and (5) evaluation of the model efficiency.

Data Collection Instruments

(1) Forms for recording document analysis for constructing the theoretical framework for development of the interactive learning environment model.
(2) Forms for recording the synthesis of design conceptual framework in order to construct the designing framework for developing the interactive learning environment model.
(3) Forms for evaluating the interactive learning environment model to be used by the experts in investigating the content, web-based media, learning environment model, and evaluation.
(4) Tool for measuring creative problem solving constructed based on the framework of Treffinger, Isaksen and Brian Dorval (2000) [6], which has 3 principle components: (1) understanding of the problem, (2) forming concept, and (3) planning implementation.
(5) An objective test for measuring learning achievement with scoring guidelines of each test item and holistic scoring.
(6) Form for surveying attitudes of learners on learning with the interactive learning environment model. The survey form was designed with open-ended questions asking for the 3 main aspects, namely, learning from the web and design that enhanced creative problem-solving thinking. Space was given for the students to add reasons and additional opinions and suggestions.

3.4 Data Collection - This Included

1. Document analysis – This involved studying and analyzing the principles and theories concerning the design of interactive learning environment model, which included psychological base, pedagogic base, creative problem solving thinking,

media, technologies base, and contextual base as the basis for synthesizing the theoretical framework for model development.
2. Theoretical framework – The framework was constructed based on the study and analysis of theories, research work, and variables. Then relationships between the theories and this research were linked with relevant research and theories until the theoretical framework could be synthesized. The following theories were taken into account: the Basis of Creative Problem-Solving Thinking Version 6.1 (Treffinger, Scott G. Isaksen, 2000) [6], basis in learning psychology (Cognitive Constructivist, Social Constructivist, Information Processing), Media Symbol System), Web-based technology, Interactive approach, instructional basis (Constructivist learning environment, Cognitive Apprenticeship), and contextual basis.
3. The teaching and learning context of the course Computer Language for Education was studied, with content analysis in the part of algorithm design. Then learners' context related to the instruction of this course was investigated.
4. Designing framework – From the theoretical framework and contextual study, the designing framework was synthesized to design the interactive learning environment with its learning components.
5. Development of the learning environment model.
6. Evaluation of the learning environment efficiency was performed by having experts checking the validity of the learning environment model and the design of the learning environment model in order to make adjustment according to their suggestions. Next, the efficiency of the interactive learning environment model was found and the experts evaluated the model design using the open-ended form. Recommendations for improvement were given with reasons for both the agreeable and disagreeable aspects. The obtained data from the experts' evaluation was analyzed, interpreted, and conclusion drawn. Accordingly, we obtained evaluative information of the learning content, web-based media, and design of the interactive learning model.
7. The expert-evaluated interactive learning environment model was experimented in the real context. During the first Phase the target group of 20 students were divided into 3 small groups of 2 students, 2 small groups of 3 students, and 2 small groups of 4 students. The students then learned the topic of algorithm design with the interactive learning environment model in order to evaluate the efficiency and improve the model to its perfection based on the research finding by Sumalee Chaijaroen (2003) [7]. After this intervention, the students completed the survey questionnaire on their attitudes, did the test on measurement of creative problem solving and did the achievement test.

4 Data Analyses

1. The experts tested the model's quality using the evaluation form for the interactive learning environment model, which was an open-ended questionnaire. The data obtained was interpreted and conclusion drawn.

2. The students' attitudes towards the interactive learning environment model collected from open-ended questions were analyzed by interpretation and conclusion.
3. The students' creative problem solving thinking obtained from the test was analyzed based on descriptive statistics, including percentages, means, and standard deviations.
4. The students' achievements obtained from the achievement test were analyzed based on descriptive statistics, including percentages, means, and standard deviations.

5 Result

5.1 Synthesis of the Theoretical Framework

The theoretical framework was synthesized using the basis from the study and analysis of theories, research work, and variables. The relationships between the theories and this research work were drawn from the related principles, theories, and research work. Then the theoretical framework was synthesized as shown in Fig. 1.

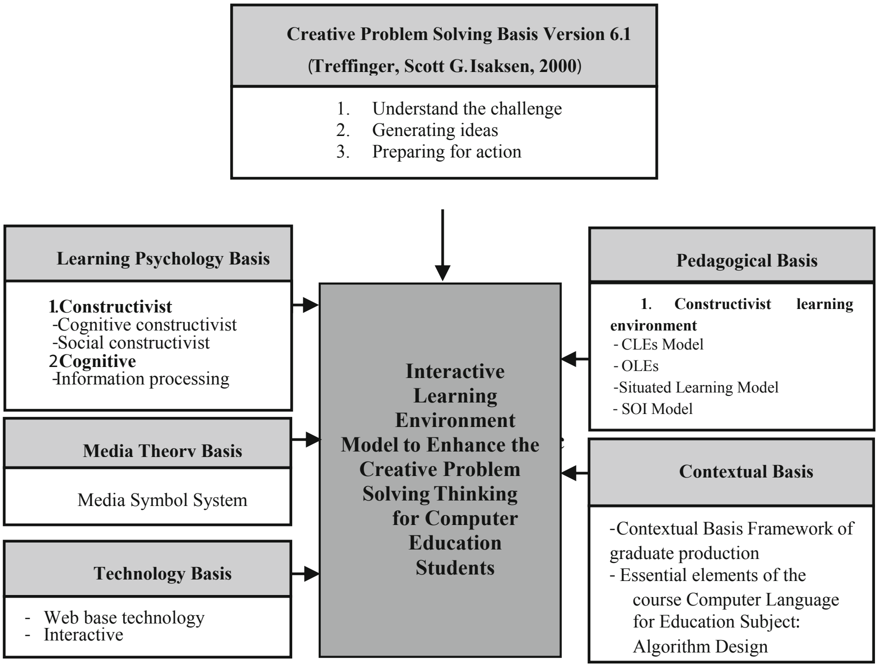

Fig. 1. Theoretical framework for designing the interactive learning environment model that enhances the creative problem-solving thinking for computer education students.

5.2 Synthesis of the Designing Framework

Synthesis of the theoretical framework of the interactive learning environment model that enhances the creative problem-solving thinking for computer education students results in the basis for synthesizing the designing framework for the interactive learning environment model, as shown in Fig. 2.

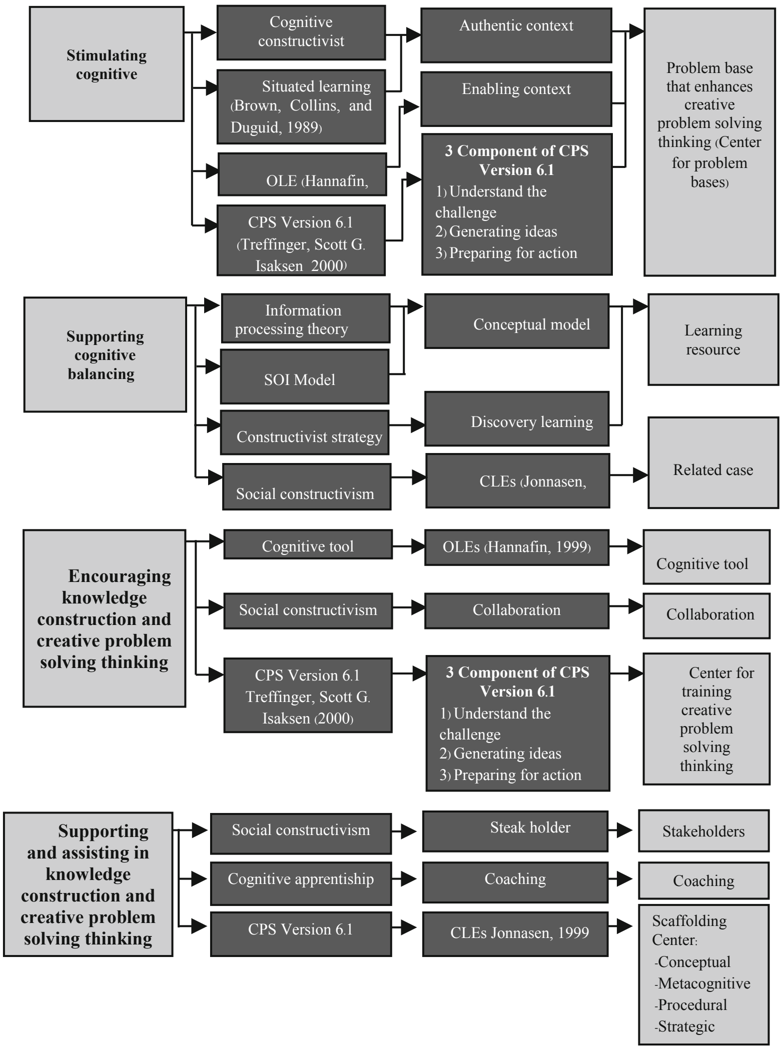

Fig. 2. Showing the results of the relationship analysis of learning achievement towards the algorithm thinking of the control group.

Following are the components of the interactive learning environment model to enhance the creative problem-solving thinking for computer education students:

Stimulating Cognitive Constructivism – Stimulation of learners' cognitive domain for knowledge construction is based on the concept of Piaget's Cognitive Constructivism. The problem base should enhance creative problem-solving thinking based on the concept of Treffinger, Scott G. Isaksen (2000) [6] which comprises 3 major components and 6 steps, namely: (1) understanding the challenge – including: (1.1) opportunity provision, (1.2) exploring data, and (1.3) framing problems; (2) idea generation – including: (2.1) generating ideas; and (3) preparation for action – including: (3.1) developing solutions and (3.2) building acceptance.

Supporting Cognitive Balancing – This was derived from the principle of Cognitive Constructivism of Piaget who believed that learning takes place when learners are stimulated by a problem that causes cognitive imbalance. We designed the following components in this respect:

Learning Resource – The center for compilation of information and knowledge that supported learners to find the answers and solve the problem based on the Discovery Learning approach.

Related Case – The emphasis was on enabling learners to be able to apply the knowledge in similar contexts.

Supporting Knowledge Construction and Creative Problem Solving Thinking – This would encourage knowledge construction and at the same time enhance the learners to develop creative problem solving thinking skills. The major components comprised:

Cognitive Tools – In order to facilitate learners in problem solving, tools are provided to support performing of problem solving activities for complicated problems so that learners would be able to define the problem and manage it.

Collaboration – This supported learners to exchange experiences and thoughts among learners, teachers, and experts in order to extend perspectives and thinking, and to prevent misunderstanding arising while learning.

Training Creative Problem Solving Thinking Skills – We emphasized learners to train in creative problem solving thinking using the design basis of Treffinger, Scott G. Isaksen [6] with 3 major components and 6 steps. This helped in reducing boredom and at the same time motivated and stimulated learners to solve the problem using creative thinking.

Supporting Knowledge Construction and Creative Problem Solving Thinking – This component promoted and supported knowledge construction by assisting learners who needed help. Counseling was provided by experts who encouraged learners to answer questions during problem solving in order to correct wrong information. Accordingly, we designed 3 major components, namely:

Scaffolding which was derived from Social Constructivism of Viotsky who mentioned the Zone of proximal development (Zdp) in the sense that if a learner is below Zdp, it means he needs assistance via scaffolding. The principle of Open Learning Environment (OLEs) developed by Hannafin [7] also stated that scaffolding assists and supports learners in problem solving or learning where the learner is unable to achieve the learning mission. According to OLEs, scaffolding takes 4 forms: (1) Scaffolding for comprehensive thinking through enabling learners or giving clues until they are able to obtain access to information resources or other learning resources. (2) Scaffolding for thinking to support learners in terms of the process related to each individual's learning management. Coaching for thinking while learning is done so that learners know how to think in order to solve the problem under the topic learned using plausible strategies. (3) Scaffolding for processes. (4) Scaffolding for strategies.

Coaching – This component supports learners to extend their thinking from the teacher's or experts' advices. Learners would consider their own thinking, and disagreement cold arise.

Stakeholders – The problem base to be solved by the students was derived from real life context. There were many people involved in the problem, and each had different views.

5.3 Development of the Interactive Learning Environment Model

The interactive learning environment model that enhances creative problem solving thinking for computer education students was designed as shown in the following Figs. 3, 4, 5 and 6:

Fig. 3. Main page of the learning environment.

Fig. 4. Problem case.

Fig. 5. Related case.

Fig. 6. Cognitive tool.

6 Discussion

Design of the interactive learning environment model that enhances creative problem solving thinking was achieved by means of the Developmental Research, Type II [5]. The research was divided into 3 phases, namely, (1) model development, (2) model validation and (3) model use. This study was under Phase 1, the design of the interactive learning environment model. It included document analysis, study of the teaching and learning context, synthesis of the design concept, design and construction of the interactive learning environment model, and quality improvement. The research findings indicated theories and learning principles that enhance creative problem solving thinking. These are the Constructivist Learning Environment and the Cognitive Apprenticeship, the Basis of Creative Problem-Solving Thinking Version 6.1 [4], learning psychology (Cognitive Constructivist, Social Constructivist, Information Processing), Media theories (Media Symbol System), Web-based technology, and Interactive approach. In the study of the design process, we obtained the conceptual framework and components in the interactive learning environment, which comprised (1) the problem case, (2) learning resource, (3) related case, (4) cognitive tool, (5) collaboration, (6) center for training thinking skills for creative problem solving, (7) scaffolding, (8) coaching, and (9) stakeholders.

7 Recommendations for Further Research

1. Study should be conducted on the results of the design of each component to see if and how it enhances learners' creative problem solving thinking, e.g., problem case, or design of scaffolding for the design of learning innovation that enhances learners' creative problem solving thinking.
2. Study should be conducted on the process of creative problem solving thinking of learners as the basis for analyzing the potential of each learner as part of the result analysis.

Acknowledgements. We would like to thank Associate Professor Dr. Sumalee Chaijoroen, the supervisor of this project, who kindly gave recommendations for the research and edited this article until its completion. Thanks are also extended to the Office of the Higher Education Commission and Office of Research Fund for the monetary support.

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The Investigation on Creative Thinking into Projected-Base Programming Course for College Students

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Abstract. The purpose of this research is to integrate creative thinking strategies and skills into a project-based programming course for undergraduate students from information engineering and engineering and sciences departments. For creativity training, this study uses Mind map tool in the course to reinforce students' divergent thinking ability, and for the projects, this study provides Arduino quadcopters and various sensors for students to program their controlled flights in order to enhance students' programming and convergent thinking abilities. The course is taught to a group of 38 freshmen from an engineering and science department in a university in southern Taiwan. Both qualitative and quantitative research methods, including programming ability test, Abbreviated Torrance Test for Adults (ATTA), and expert's participant observations, are used in this research for evaluating the course performance in a one-group pretest-posttest design. The results in students' programming ability tests indicate that the programming ability of students is positively and significantly improved by the project-based course. From the after-course surveys and the expert's participant observations, this study finds students, after hand-on projects, show strong learning interest and motivation. From the ATTA tests, this study can confirm the positive enhancement in students' creativity after they participate in the creative project-based programming course, but there is no significant difference in the overall creativity performance between the ATTA pre- and post-tests. Suggestions are provided in this study to further strengthen the effectiveness and efficiency of future instruction and investigation in relevant courses.

Keywords: Programming learning · Creativity · Creative thinking strategies and skills · Project-based learning

1 Introduction

In the wave of globalization, innovative software product is one of the key powers to enhance international competitiveness of the software industry. It is an urgent issue to enhance creativity of software personnel. On the other hand, programming is an important basic skill for software industry personnel. It is an indispensable ability not only for information engineering, but also for engineering and sciences students today.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 713–725, 2019.
https://doi.org/10.1007/978-3-030-35343-8_75

Therefore, how to improve both students' creativity and programming ability becomes a vital concern in colleges. In the future, creative thinking, critical thinking and problem-solving ability are the key of a country's competitiveness. Technology is essentially the realization of creativity. The actual participation of it is also a crucial learning channel for students [18].

Isaksen et al. indicated that creativity can be trained [13]. It can inspire students to actively learn to find and solve problems through the design of various learning activities. Therefore, how to integrate creativity training into courses has become an important issue. In addition, many studies showed that a lot of creative thinking strategies and tools is able to enhance students' creativity. In creative teaching activities, students usually use divergent thinking to think about problems and convergent thinking to output solutions. Common creative thinking strategies and tools include mind maps, concept maps, fishbone diagrams, mandala methods, etc.

As previously mentioned, creativity is very important and programming is the basic ability necessary for college students in information-related departments. Common programming teaching method is a teacher lecturing the syntax to students and giving them homework to practice, which rarely includes the elements of creativity training. Elements like Creativity and interdisciplinary learning are absent in current programming curricula. Owing to this situation, it is difficult for students to code creative software applications.

This study is to design a course with creativity training for students of information-related departments to enhance their creative programming ability. It is based on creative thinking strategies and training tools as well as programming-oriented projected-based learning using an Arduino quadrotor. It also complies with the steps in the Creative Problem Solving model to help students generating good ideas and plans for finishing their own projects.

2 Literal Review

This study establishes a course to help enhancing creative programming ability of students in information-related departments. The course comprises with creative thinking training tools and programming-oriented project that require hands on activities.

2.1 Creativity and Creative Thinking Skill

Creativity is the ability to develop, through brainstorming and convergent thinking, novel and valuable ideas. Researchers have been trying to define what is the creativity.

Howard Gardner believed that creativity is the ability to solve problems and procedure outcomes, as well as to ask new questions [8]; Guilford also believed creativity is the individual ability to create or to integrate existing ones to form new ideas or products [10]; Ken Robinson defined creativity as an imaginary process that produces original and valuable results [23]; Parnes pointed out that creativity is a reflection and response journey consisting of linking previous experiences and responding to stimuli to summarize one unique outcome [20].

Guilford pointed out that creativity requires two important thinking skills, one is divergent thinking for getting innovative ideas, and the other is convergent thinking for producing feasible solutions [10]. Therefore, previous creativity enhancing strategy focused almost on improving these two thinking skills. Creativity development tools commonly used in engineering in the past were Osborne checklist [19], SCAMPER [7], TRIZ [1], etc. From the aspect of inspiring students' creative thinking skill, the key to successful creativity training lies in the application of creativity development strategy. Through effective strategies, it is an efficient way to stimulate students' creative thinking. Therefore, combining creativity development strategies and tools into creative thinking activities in the curriculum will stimulate and encourage students' creative behavior. The general creativity training activities usually ask students to think divergently first for brainstorming ideas and then gradually guide them to think convergently for seeking feasible methods or for constructing the most appropriate output from generated ideas.

Brainstorming. Brainstorming is a technique of generating ideas, proposed by Alex Osborn [19], who defined brainstorming as "everyone uses their brains to think creatively to produce a potential solution to a particular problem." This technique is, via group thinking, to generate ideas and lead to creative thinking. The main goal is to stimulate and enhance the creative ability of each participant. Brainstorming methods can be carried out by one or more people. There are four principles that must be adhered to in the activity of group brainstorming:

1. Do not criticize the opinions or ideas of other participants.
2. The more ideas and opinions, the better.
3. Free thinking, using imagination, and allowing whimsical opinions.
4. Allowing to combine many of the ideas of others into improved opinions.

A brainstorming should focus on a specific topic, let everyone put forward freely the ideas in the brain, and finally classify and organize the ideas generated by all members to generate new aspects and solutions to the problem.

Mind Map. It is an image-based tree structured divergent thinking mode proposed by British scholar Buzan [3]. It uses a combination of lines, patterns, colors, keywords, symbols, and other categorization concepts to build personal thoughts and their structured divergent associations when brainstorming. A lot of Mind map tools have been built since. The Mind maps are more likely to inspire creativity than traditional itemized thinking, and can make thoughts clearer when analyzing problems. It can better grasp the logical relationships of key influencing factors of a problem. Because its main trait is to set a central theme and extend it from different aspects; it is often applied to the divergent thinking stage. An example of a mind map is shown as in Fig. 1.

The four basic elements are as follows:

1. Presenting the subject of thinking with a specific central image in the center.
2. Write the main concepts generated by the subject of thinking by branches of the central image.

3. On each branch extended, draw one key image and/or give it a concept keyword. The secondary concepts are all branches of the main concepts, and so on.
4. All branches form a linked-node-like structure.

Fig. 1. A Mind map example (tool Coggle used)

2.2 Project-Based Learning Strategy

Project-based learning is derived from constructivism with emphasis on the learning by student-centered activities. It advocates learning from hands-on activities. It is a kind of teaching activity modeled around hands-on projects. The process of the project-based learning is to provide students with complex and practical questions, to enable students, based on questions of challenges, to plot action plans, collect reference materials, design solutions, establish decision-making actions, perform problem solving, and complete the exploration and present the final works. The teaching activities of project-based learning usually is a six-stage process, and may be repeated in no specific orders. [9, 16]:

1. Decide on course objectives and the concepts included: Teachers determine the goals of the project-based learning activities and the concepts they need based on the objectives of the course, as the basis for learning activities.
2. Develop guiding questions: guiding questions is the center of the whole project-based learning. These questions can inspire students' interest in learning and guide them the direction of learning. Teachers, according to the course objectives, select appropriate guidance questions to help students enter the exploration activities to achieve concepts learning activities goal.
3. Develop a basic course: Teachers, based on the course objectives and the students' prior knowledge, develop a basic course. The course content provides the knowledge or skills that students need in their learning activities.
4. Develop investigation activities: Teachers, as the role of facilitators and guiders, help students conducting relevant investigation activities.
5. Develop activity schedule: When planning project activity, a schedule of the activities must be settled to help guiding the entire project course.

6. Develop assessment model: Teachers must select appropriate assessment methods based on the nature of the project activities, such as: work evaluation, group mutual evaluation, journals, interviews, checklists, concept cognition maps, etc.

Many researchers have also applied the project-based learning strategies to programming teaching and achieved good learning results. Chang used the 635-brainstorming method as an enhancement to the project-based teaching activities for the college students' C++ creative programming curriculum. The research findings confirmed that, for students, creativity has a positive and significant impact on the effectiveness and attitude of programming learning [4]. Chu and Hwang also used the cooperative project-based learning method in the Visual Basic programming course of a university to improve students' programming language learning effectiveness, learning motivation, and problem solving ability [5]. The characteristics of project-oriented learning include: learner-centered, emphasis on real-life problems, practical application of conceptual principles, interdisciplinary learning, and development of complex problem-solving skills. These characteristics inherently complies with the integration, hands-on, and application of engineering. Therefore, this study uses project-based learning model as the framework for programming teaching activities.

2.3 Creative Problem Solving and Programming

Creative Problem Solving (CPS) is initiated from Osborn and Parnes, who believe that creativity can be enhanced through training [19, 20]. They advocated that through brainstorming, judging constantly, encouraging free association and imagination, and seeking all possible solutions, etc. creative thinking and problem-solving skills can be enhanced [19]. Osborn believed creative thinking must consist of three parts: finding facts, finding ideas, and finding answers. Finding facts involves two steps: defining problems and preparations; finding ideas creates potential ideas; finding answers is to evaluate and choose the best idea. Parnes extended Osborn's three steps to a five-steps problem solving model, including Fact Finding (FF), Problem Finding (PF), Idea Finding (IF), Solution Finding, (SF), and Acceptance Finding (AF) [20]. The Parnes' CPS model was revised later on. Except changing "Fact Finding" to "Data Finding (DF)", Isaksen expanded Parnes' CPS model with a first step "Mess Finding (MF)" to form a six steps model. Then Isaksen and other scholars found that when people solve real life problems, they naturally combine these six steps into "preparation problems", "inspire ideas" and "action plans" three parts and defined CPS as six steps in three components [13] as follows:

Ingredients 1: Understanding the Problem

Step 1. Mess Finding (MF): Set a goal, a task or a problem.
Step 2. Data Finding (DF): Explore various aspects of the targeted problem and decide what to focus on.
Step 3. Problem Finding (PF): develop, refine, and clarify the narrative of problem.

Ingredients 2: Generating Ideas

Step 4. Idea Finding (IF): Explore and gather ideas that can solve the problem.

Ingredients 3: Planning for Action

Step 5. Solution Finding (SF): Develop evaluation criteria to evaluate ideas.
Step 6. Acceptance Finding (AF): Develop a specific action plan and implement it.

In programming, learners may face various problems and may need be creative in finding solutions. Researches have applied the model of creative problem solving to the programming discipline. Deek and his peers defined the programming problem solving process in four steps: understand the problem and needs, plan a solution, write a program, and test and debug the program [6]. These steps fit comfortable into the six steps and three components of the latest CPS model as shown in Table 1. Such a fitting implies programming training is not just to train the ability to think logically but also the creative problem-solving ability, i.e. ability to develop programs with novel ideas.

Table 1. Comparison of problem resolutions by Deek and Isaksen et al.

Programming		Creative problem solving	
Four steps	Description	Six steps	Three components
Understand the problem and needs	Clarify the relevant information contained in the problem	Mess Finding (MF)	Understanding the problem
	Clarify the input/output requirements of the problem	Data Finding (DF)	
Plan a solution	Decompose the problem into several sub-problems and steps	Problem Finding (PF)	
	Plan to construct modules for sub-problems in solving the problem	Idea Finding (IF)	Generating ideas
Write a program	Write a program to implement the designed problem-solving plan	Solution Finding (SF)	Planning for actions
Test and debug the program	Test and confirm the correctness of the program and correct errors	Acceptance Finding (AF)	

3 Methodology and Materials

This study integrates creative thinking strategies and skills in a project-based programming course for undergraduate students from engineering college. For creativity training, this study uses Mind map tool in the course to reinforce students' divergent thinking ability, and for the projects, this study provides Arduino quadcopters and various sensors for students to program their controlled flights in order to enhance students' programming and convergent thinking abilities.

3.1 The Methodology

This study follows the three components of the CPS model and designs a set of project-based programming courses aimed to enhance students integrate creative thinking and programming abilities. A Mind map tool is used for students to brainstorm and, using the ideas they generate, students converge to a final project. An Arduino quadrotor with various sensors is used as a control target for the programming course and for students' final project. The students' prior knowledge of programming is also a major concern for designing the course. The course consists of Mind map tool introduction, knowledge and techniques required for programming the Arduino quadrotor and its sensors, and the exploration and design of a final project. The flow chart of the methodology is shown as in Fig. 2.

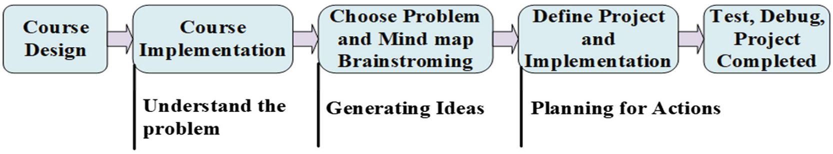

Fig. 2. The flow chart of the methodology

3.2 The Course Design and Implementation

The course consists of 6 lessons for teaching activities, including introduction to Mind map tool and brainstorming approach, basic Arduino programming and Arduino quadrotor, Arduino program structure and programming for flying the Arduino quadrotor, introduction to Arduino sensors and their controlling programs, Arduino quadrotor with sensors, creativity training with Mind map tool, and design of creative quadrotor projects. The simplified course structure is shown as in Table 2.

4 Experimental Results and Discussions

In order to evaluate students' performance on creativity and programming ability, this study uses a combination of qualitative and quantitative research methods, including programming ability tests, Abbreviated Torrance Test for Adults (ATTA), and expert's participant observations. The programming ability test and ATTA evaluate students' programming ability and creativity by pre- and post-tests respectively. The programming ability test contained 13 exercises on variable, determine statements, control statements, function, array, object, class, etc. The ATTA consisted of 4-scale evaluations, including fluency, flexibility, originality, and elaboration.

4.1 Experimental Method

The course continues for 8 weeks, which is taught to 38 freshmen, who form 19 groups, are from an engineering and science department in a university in southern Taiwan. The pre-tests finish in the first week before the course starts. Six project-based course activities are arranged in 6 weeks with each course activity lasting for 60 min. During the courses, participant observations are carried out by teachers and experts to record students' activity, behavior, and performance in the class for final qualitative analysis. The post-tests on programming ability and creativity are held in the final week. The experimental process is as shown on Fig. 3.

Table 2. The structure of the course

Course name	• A project-based programming course incorporating creative thinking strategy
Course subject	• Programming, Creativity
Teaching object	• Engineering related college students
Evaluations	• Programming Ability Assessment, Abbreviated Torrance Test for Adults (ATTA), Project Evaluation
Total time	• Total six lessons, each lesson last 60 min
Teaching objectives	• Brainstorming technique • Microcontroller Arduino programming ability • Learn to control the quadrotor by C++ programs • Understand and be able to use s sensors of a quadrotor • Finish a project for the quadrotor to fly and sense environment
Teaching activities	• Course Content and Activities
Lesson 1 Meet the Mind map tool, Arduino, and the quadrotor.	• Introduce the Mind map tools • Introduce the usage of web-based map tool Coggle • Introduce the basics of a quadrotor and hardware equipment • Explain how to use the mobile app to control the quad rotor • Mind map tool exploration and first example brainstorming • Control the Arduino quadrotor flight via mobile phone app
Lesson 2 Know the program architecture of Arduino and the quadrotor and write a simple program to control the quadrotor.	• Explain the flight control program architecture of the quadrotor • Explain how to combine the Arduino quadrotor flight control program and the C++ flight control script programs • Explain Arduino quadrotor calibration and program debug • Install the required Arduino programming environment • Write C++ flight control script program and burn it to the Arduino quadrotor for the specified flight test
Lesson 3 Meet Arduino sensors, and their control methods.	• Introduce the working principles of Arduino sensors and their control methods with sample programs • Students modify the sample programs and burn them to the Arduino quadrotor for testing the application of the sensors
Lesson 4 Learn the Arduino quadrotor flying with sensors.	• Explain how to add the Arduino sensors into the quadrotor • Explain how to combine the quadrotor flight control program, the C++ flight control script programs, and sensor control program • Students write programs that combine the Arduino quadrotor flight control program, the C++ flight control script programs, and control program of sensors and burn them to the Arduino quadrotor for testing the controlled flight with object sensing • Mind map tool brainstorming again

(*continued*)

Table 2. (*continued*)

Lesson 5 Use creative problem solving techniques to design a final project for Arduino quadrotor	• Explain the objective and the requirements of the final project • Require students to brainstorm by Coggle on the final project by using all the materials learned so far • Students use Coggle to brainstorm all the ideas that involve Arduino quadrotor, sensors, control programs, and etc
Students converge ideas into a potential doable project and implement the project in one week	
Lesson 6 Final project demo and evaluation	• Final project evaluation • *Students explain their final project by films, PowerPoint slides, and the control programs and demo the flight of the Arduino quadrotor*

In this study, the post-tests use the same questions as that of the pre-tests in order to understand changes in students' creativity and programming ability. This study studies on the collected data, including students' scholastic tests, ATTA, participant observations to evaluate how the course affect students' programming ability and creativity.

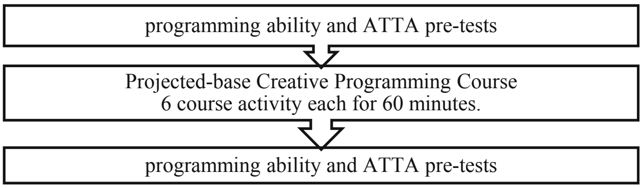

Fig. 3. Experimental process

4.2 The Programming Capability

The results of the paired-samples t-test on the pre- and post-tests in programming ability tests is presented in Table 3. The Cronbach's α is 0.821, which confirms a good reliability of the tests. The result of the *t*-test indicates a significant difference ($P < 0.05$) on student's programming ability before and after the course. Some of the observations by the experts are given in Table 4.

Table 3. Results of the paired-samples *t*-test on programming capability

	Paired differences					*t*	*df*	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	95% confidence interval of the difference				
				Lower	Upper			
Programming capability	−7.687	10.059	1.778	−11.314	−4.060	−4.323	31	.000

Table 4. Some of the participant observations

- Students were interested in using the App and coding in order to control the quadrotor.
- Few students used mobile phones during the lecture.
- Most students were willing to stay to finish practices after class dismissed.
- Few students asked questions about Arduino program architecture and C++ class concepts.
- The majority of groups considered that Arduino quadrotor could not fly accurately in accordance with the programs.
- Few students had tested and found out that some sensor problems on the program conflicted with the quadrotor motor and caused bad flight situation.

The participant observations show some students are distracted when the teacher is lecturing. However, they become highly focused on programming the quadrotor. Although the low-cost quadrotor cannot fly stably, students are still very interested in programming for controlling its flying. One key objective of the course is to stimulate students' interest in programming by using the quadrotor and by a creative final project, which can be confirmed reached. The results of the programming ability tests and the participant observations indicate that the integration of creative thinking skill into projected-base programming course has positive influences on learning programming.

4.3 The Creativity

The scores of ATTA in pre- and post-tests are analyzed by the paired-samples t-test. The result is shown in Table 5. The performances of creativity in originality, elaboration, flexibility, and overall scores, except fluency, are not significant ($P > 0.05$). Some of the participant observations by the experts are shown in Table 6.

Table 5. Results of paired-samples t-test on the creativity

	Paired differences					*t*	*df*	Sig. (2-tailed)
	Mean	Std. deviation	Std. error mean	95% confidence interval of the difference				
				Lower	Upper			
Fluency	−1.250	1.626	.287	−1.836	−.663	−4.348	31	.000
Originality	−1.562	2.287	.404	−.981	.668	−0.386	31	.702
Elaboration	−.5000	1.135	.200	−.909	−.090	−2.490	31	.018
Flexibility	−0.937	1.837	.324	−.756	.568	−0.289	31	.775
Overall score	−2.843	6.520	1.152	−5.194	−.492	−2.467	31	.019

Table 6. Some of the participant observations

• Most students discussed the project topic enthusiastically.
• Some students asked questions about sensors to confirm their ideas are feasible.
• Although some groups had drawn many ideas on their mind maps, but only a small amount of project topics was proposed.
• Some of the groups had used straws, wires, rubber bands, hot melt adhesives, and other materials to assist in creation.
• Most students tend to design toy-related applications with little practical values.

One reason that the overall creativity improvement is not significant might be that the time for using creative thinking tool is less than 60 min. Although students are trained to generate more ideas than they do in the beginning of the course, confirmed by the significant improvement in fluency factor, they do not get used to the skill of converging ideas to a meaningful project. The participant observations also show that the use of Mind maps tool can trigger more ideas, but students find it difficult to merge so many ideas into real applications. Because students continuously examining the different topics of the course, a lot of ideas are generated during the course of finishing their final projects. Therefore, the familiarity with the course materials may also affect the number of ideas, i.e. the fluency factor. Some students propose very creative projects and complete their projects on time, others also come up with creative project, but fail to complete the project on time due to lacking of adequate programming skills and knowledge. Although students are observed creative in exploring their projects, the truth there are no significant differences in other factors makes this study to wonder. Whether the time for implementing the creative strategies and using the Mind map tool in the course is insufficient or not remains for further investigations.

Feedbacks from students are also valuable for improving the course in the future. Among all the feedbacks, one says “I feel that the content of the course and the programming knowledge I have learned before are not so consistent.” The reason for this might be that although the participants have basic concepts of programming, they feel difficult on coding the Arduino quadrotor because they are freshmen and most of them are beginners in programming. The other says “I feel that it is difficult to coding for flying the Arduino quadrotor”. The reason for this is believed to be that the low priced Arduino quadrotor cannot fly stably which sometimes makes students wonder if the logic of their programs are wrong.

5 Conclusion

To promote creativity programming abilities, this research integrates creative thinking strategies and skills into a project-based programming course for undergraduate students from information engineering and engineering and sciences departments. For creativity training, this study uses Mind map tool in the course to reinforce students’ divergent thinking ability, and for the projects, this study provides Arduino quadcopters and various sensors for students to program their controlled flights in order to enhance students’ programming and convergent thinking abilities. To finish a project requires grouped students to use Mind maps tool to explore ideas, to debate and converge to the project through panel discussions, and to implement the project, which is to program for flying an Arduino quadrotor and controlling other sensor components. To investigate the feasibility of the course, this study uses both qualitative and quantitative research methods, including programming ability test, Abbreviated Torrance Test for Adults (ATTA), and expert's participant observations. The performance of the course is evaluated in a one-group pretest-posttest design. The results indicate that the project-based creative programming course can positively and significantly improve students' programming ability and positively enhance students' creativity. The participant observations also show that students are much more interested in learning programming by combining theories and hands-on projects. The drawback that the course is too short for using creative thinking tools remain to be corrected.

Acknowledgement. This study is partly supported by the Ministry of Education (Taiwan) under the project contract No.: PEE107003.

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Social Media Learning

Integrating Social Media into Problem-Based Learning to Improve Students' Learning Performance

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Abstract. Research into the impact of social presence on students' learning performance in the online-based problem-based learning (PBL) context is rarely extended in clinical training courses. The constructs of social identification and trust in community members, especially in the current intern group, cannot be overlooked because students encounter a variety of the problem-situations can change constantly. In such circumstances, a collaborative learning process may quickly help students make decisions based on their skills/abilities, experiences, and information in order to achieve their learning goals. According to in-depth interviews with the instructors, this study proposed a model to investigate students' learning performance that has been used in medical or nursing education but is not yet generally available in the fields of aesthetic medicine or cosmetic/plastic surgery education. Therefore, we expect the results of this study to provide a valuable reference for the PBL design that will enhance students' professional abilities and skills via their identification and trust in their community and will improve their reasoning skills during clinical training courses. Likewise, the findings may contribute to the ability of instructors to manage their courses and provide the information needed for their students promptly and effectively via virtual communities.

Keywords: Problem-based learning · Social presence theory · Social capital theory · Learning performance

1 Introduction

Recent advancements in mobile technology have brought about radical changes in the global teaching and learning environment. Medicine and nursing education modes have shifted from teacher-centered instruction to student-based learning [1]. For example, problem-based learning (PBL) curricula have been proven to be more dynamic and pragmatic approaches to the development and implementation of higher-order thinking skills for medical or nursing students with the goal of improving learning outcomes. PBL motivates students to acquire and organize information and apply prior knowledge in order to analyze, evaluate, and solve problems. The learning performance may be defined as how a student can successfully solve problems through collaborative efforts among students. In an online-based PBL context, students are more likely to participate

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 729–737, 2019.
https://doi.org/10.1007/978-3-030-35343-8_76

in a given learning task or activity. Research demonstrates that PBL is a more active learning approach than traditional teacher-centered instruction [2]. An online-based PBL program can facilitate and support active learning, critical thinking, and problem-solving skills in students [3]. There are significant differences between the current PBL and online-based PBL in clinical training courses that are worth further exploration. Additionally, there is a lack of an explicit understanding of the PBL approach in terms of the clinical training education that takes place in the aesthetic medicine or cosmetic/plastic surgery context. In the clinical training context, students can gain a broader base of knowledge from peers and real-world patients that will enhance their professional abilities.

PBL is an individual project or group activity where students can learn together by working on complicated, practical problems under the guidance of a tutor. Because clinical training courses are required courses, PBL can help students explore their professional work environment and integrate theoretical knowledge into practical application. In both healthcare and medical services in the 21st century, it is difficult to formulate standards for the quality of services because of a variety of problems are related to complex and imperfect information. Therefore, online-based PBL may be suitable for clinical training courses intended to solve various issues in students' learning processes. It can be used to supplement traditional instruction by incorporating a vast array of ideas/concepts from multiple learning resources that will enrich students' understanding [4] and further foster their problem-solving abilities. In such cases, there may be psychological challenges, but these challenges can be overcome by the social interaction among students that occurs in a virtual communication space [5]. This study, therefore, is aimed toward investigating the effects of social presence on students' learning performance in clinical training courses, which to date has been ignored in the existing literature.

The online-based PBL context is an extension of classrooms that allows instructors and students to utilize their spare time to contribute their recommendations, ideas, and opinions. However, there are some principles by which PBL operates that have to be determined and defined in the online/virtual context. Chickering and Gamson [6] suggested that best practice includes seven principles for instructors in the online/virtual context: encourages student-instructor contact, increases opportunities for reciprocity and cooperation among students, encourages the use of active learning techniques, provides prompt feedback, emphasizes time on task, communicates high expectations, and respects diverse talents and ways of learning. Instructors and students must be familiar with and be able to implement these seven principles because they may enhance students' confidence in knowledge transfer, help them make decisions related to their learning tasks, and improve their professional skills.

Although many studies have examined the advantages and disadvantages of PBL in the online/virtual context [7], few studies have focused on learning performance in response to relationship quality. Based on the social presence theory and social capital theory, this study investigates students' interactions in the online-based PBL context specifically as they relate to social presence, identification and trust in community members, active participation, and reasoning skills because there have been few studies addressing these issues. We expect online-based PBL to be suitable for clinical training courses from the perspective of individual social presence and relationship quality. Therefore, the research proposition is proposed as follows:

- Proposition: How does social presence affect students' identification and trust in community members and in turn increase their active participation in decision making activities that will improve their reasoning skills?

Since students often feel lonely and experience a lack of a sense of belonging during their internship period, this study is an attempt to investigate how social presence affects their affective reactions and actions and in turn, how it influences their interaction and learning performance in clinical training courses. Theoretically, this study is aimed toward investigating the feasibility of the online-based PBL approach to measure students' learning performance via various social technologies within the framework of social theories.

2 Theoretical Background

The advancement of social technologies enhances students' learning experiences on Facebook, Twitter, WhatsApp, LINE, and blog [8, 9] and significantly changes the way that students access learning materials/contents and discussions. In higher education, since teaching and learning technologies constantly change, the effectiveness of tools and methods to promote students' knowledge transfer and improve their learning performance is always considered. The technology-driven and standard/traditional learning methods for students are compared to generate different results for the enhancement of learning performance [10]. Eid and Al-Jabri [11] found that only knowledge share has a positive influence on students' learning performance, but chatting and discussion, file sharing, content creation did not, and that suggested that instructors should be encouraged to use WhatsApp, YouTube, Dropbox, and Facebook for group discussion, file sharing, and content creation. Therefore, the PBL approach may be a feasible teaching/learning method in an internship context.

2.1 Social Presence Theory

Social presence is a crucial factor of communication medium and originated from a subfield of communication theory. It is defined as the degree of significance of other students interacted in an online/virtual community and the consequent quality of the interpersonal relationships [12]. Therefore, a social presence can be categorized into three distinct dimensions: co-presence, intimacy, and immediacy [13, 14]. In other words, social presence is a measure of students' experiences (i.e., cohesion) in the intern groups where students learn together to optimize the knowledge generation and the serialization of information/knowledge, record analysis, and feedback. Therefore, many psychological factors, namely awareness, attentional allocation, empathy, mutual understanding, behavioral interdependence, and mutual assistance, are involved in the social presence [15]. Subsequently, social presence theory becomes an important concept in online/virtual learning environment [14, 16]. It can be inferred that students are likely to be more engaged in group interactions or activities to complete group task assignments. In an online classroom or computer-mediated community, social presence is one of the key determinants of learning interaction and participation and leads to the improvement of students' learning performance [14]. Moreover, a group with high social presence would possess more interactive information, and thus, students would perceive useful, attractive, and credible information in such a group. Social presence is important to instructors who desire to deliver their knowledge or educational programs and students who desire to achieve their learning tasks and improve learning abilities for effectively using learning technologies.

2.2 Social Capital Theory

The popularity and rise of social technologies affect the development of learning technologies which allow instructors and students to form a close relationship with each other. In that case, social capital theory is a powerful framework in explaining how a variety of specific resources, behaviors, and outcomes are operated in online/virtual communities [17]. Social capital has been defined differently based on research goals and objects. A simple definition is the connections among individuals, namely norms of reciprocity, social networks, and trustworthiness that arise from an individual or social unit [18]. Social capital can be categorized into three dimensions: structural, relational, and finally, content/communication [19].

Developing social capital is vital for the PBL method; however, theory-based research on the interaction between social capital and PBL in internship context has not been extensively studied. Since the internship is dynamic, many factors, such as trust in community members and students' identification, influence the learning performance of the intern, and thus this study employs relational social capital to investigate students' participation and relations in their intern groups.

Trust is a domain-specific psychological state (ex. an individual's beliefs or willingness) which is different from behavior [20]. Trust is an important determinant of collaborative learning among peers in an intern group by connecting community members to identify, share, and adapt themselves in the internship. In considering commonly shared norms in an intern group, trust can be defined as "the expectations arise within a community of regular, honest, and cooperative behavior on the part of other members of that community" [21]. In general, trust is generated and fostered by repeated interactions among students, and useful information or knowledge would be shared within the intern group if they are trusted with each other.

Social identification is a dynamic process which is embodied in an interactive context and considered one of the critical parts of relational social capital. Social identification is defined as the degree that an individual experiences a sense of oneness with or belongingness to an intern group [22]. Thus, it is necessary to investigate further the role of social identification in collaborative learning and knowledge sharing in the PBL context, which is rarely discussed in the literature.

Research on relationship learning has not drawn a great deal of attention in the PBL literature, especially the theme of knowledge transfer during the internship. Besides, the practical training courses emphasize higher-level thinking and knowledge transfer based on data collection, and further to perform analyses for making an adequate decision promptly when students encounter specific tasks or problems. Thus, trust and social identification are significant motivators for community members to form relationships, which cannot be separated from the social context. Subsequently, Kamboj et al. [23] reported that relational social capital has a positive impact on the firm's performance. Nahapiet and Ghoshal [24] stated that the high degree of identification might enhance the quality of cooperation to knowledge creation, information sharing, and learning. The relational social capital of knowledge sharing/transfer in a PBL context has not been fully elaborated in the existing literature. Thus, this study considers the relational social capital to investigate when and why the students would collaborate and share knowledge with others in an intern group.

3 Research Method

3.1 Participant

Social presence has a positive impacts on students' learning performance; however, there is a lack of evidence indicating that social presence influences students' learning performance. In an online-based PBL context, students' active participation and reasoning skills are linked with their interactions. We also note that previous studies have rarely elaborated on these two variables in clinical training courses. It is a great challenge to collect data from students whose internships are scattered across multiple cities or counties. Therefore, some procedures were implemented in the current study to ensure an overall evaluation of the research questions. First, the authors surveyed the existing literature and empirical research on the topic (see Table 1). Second, we used a semi-structured interview tool to interview seven clinical instructors from various schools and hospitals to develop our research model in order to narrow the gap between practice and theory. In addition, the interview process with seven instructors was not directed and guided by the authors. Therefore, the results are objective and thus could provide a precise direction to develop the proposed model. Finally, we developed a questionnaire based on the previous literature and the comments collected from the clinical instructors. A multiple-item scale method was used in each construct for the questionnaire, which was distributed directly to the students (major in cosmetic and nurse), as well as via online (Google forms) or E-mail.

3.2 Research Framework

As shown in Table 1, in recent years, online-based PBL has attracted numerous researchers to explore and compare different methods, factors, and tools influencing medical or nursing students' learning outcomes. Based on previous research, this study is an attempt to assess how online-based PBL promotes student engagement and enhances their competence. Thus, the proposed model includes social presence, trust in the community, social identification, active participation, and reasoning skills (see Fig. 1). We investigate the effects of online-based PBL on students' reasoning skills in a clinical training course context. The results of this study will provide instructors/students with guidelines for actively sustaining long-term relationships

Table 1. Online-based PBL summary.

Authors	Objectives	Online tools	Evaluating methods
Oliver and Omari [25]	This research explores the factors which contributed to students' motivation and enjoyment of learning in the online-PBL setting	Bulletin board; WWW	Quantitative study (questionnaires; interviews)
Oldenburg and Hung [26]	This research explores the factors determining students' motivation and enjoyment of learning in an online PBL environment	–	Qualitative study
Reilly et al. [27]	This research highlights the importance of students' thinking processes, actively participate, and teacher supporting pedagogical moves in technology-mediated PBL	MED Lience; Sony DCR SR68 Handy Camera; Amazon S3 console	A quasi-experimental study
Ding and Zhang [28]	This research investigates the effects of feasibility and acceptability on clinical attachment using WhatsApp to supplement medical education	WeChat	A quasi-experimental study
Raiman et al. [29]	This research investigates the effects of feasibility and acceptability on clinical attachment using WhatsApp to supplement medical education	WhatsApp	Qualitative study (structured interviews)
Bizzocchi and Schell [30]	This research develops a video-based, rich-narrative case study for online PBL tutorials that offer students immersive learning experience	Multimedia network (eLive Elluminate)	Focus group study

within the intern community and encourage them to participate and share professional knowledge in the future.

4 Discussion and Conclusion

The literature review and the clinical instructor interview responses helped us to identify several key points in the online-based PBL learning environment. This context can offer an immersive experience and a remarkable advantage for students to collaborate with others in activities to solve authentic problems. An effective online-based PBL must include several features: structured small-group learning tasks, action plans,

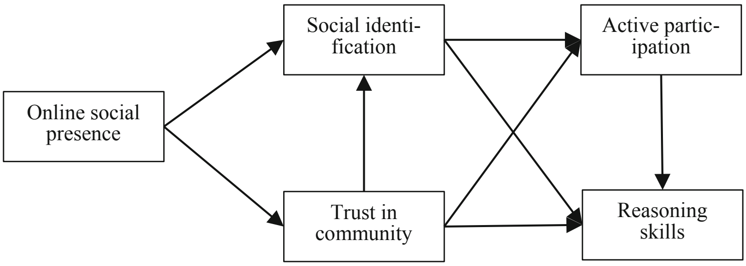

Fig. 1. Online social presence improved students' reasoning skills.

complicated and poorly structured problems, clearly stated subject goals, and supported tutorial processes, among others. Additionally, learning performance has to depend upon the knowledge of skilled teachers and additional intrinsic structures. Moreover, students have to participate in discussions and share knowledge/information in meaningful ways to improve their reasoning skills.

Most of the studies and the results of our interview suggested that online-based PBL can develop the reasoning skills in students that will be helpful for their clinical-based problem-solving tasks. They also revealed that online social presence can be used to support student trust in community members and identification of collaborative learning environments and thus can scaffold their problem-solving skills. This study also has some implications for practice and/or policy. It suggests that clinical instructors should be concerned about pedagogical strategies that will support students' reasoning skills. Online-based PBL can improve knowledge acquisition, and thus, students and tutors should develop technological literacy in order to facilitate their knowledge transfer skills. The online-based PBL context has to be supported by good planning processes as well as continuous monitoring by tutors of student cognitive processes and peer collaboration in communities.

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Students' Innovative Education Practices Supported by Facebook

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Abstract. This article describes a case study on how Facebook can be used in different ways to create new innovative learning strategies and opportunities for practicing social work related to children and adolescents. The study concerns information and communication in groups and networks on Facebook as a communication channel. Using qualitative methods, the students' use of this digital network was observed to identify the opportunities and challenges that arose in connection with innovation. Diffusion theory was used as a frame of reference for the study. The findings show that social network communities for social work education should be included as a more defined topic in research on social work. This study helps to accentuate the importance of additional research on the topic.

Keywords: Social media · Social work · Innovation · Diffusion · Learning processes · Communication

1 Introduction

This article describes how Facebook can be used in different ways to create new innovative learning strategies and opportunities for practising social work related to children and adolescents. The investigation is based on a case study on the use of social media in the education of child welfare officers. The term 'innovation' has been conceptualised at the level of the individual or organisation [1–6]. It is a key term in numerous strategies, reports, research projects, etc., but it is defined in different ways. In general innovation is more or less understood to mean: the introduction of something new, a new idea, method or unit,[1] or a similar definition[2]: a new method, idea, product, etc. One of the main driving forces for innovative development and social change is the rapid development of technology. The Internet is a major resource with its massive knowledge base. Social media platforms[3] are part of this technological development, as these web-based services facilitate communication, where many people communicate with each other, and the users largely decide on the content and usage themselves. The use of information and communication technology (ICT) has led to substantial changes

[1] Merriam-Webster Dictionary.
[2] Oxford English Dictionary.
[3] Facebook, Wikipedia, YouTube, blogger, Twitter, Instagram, Snapchat.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 738–753, 2019.
https://doi.org/10.1007/978-3-030-35343-8_77

in the organisation of work, work practices and the way people communicate via social media. Users play a key role in the shaping of innovation processes, because they influence the social aspect of innovations, modify and improve the products, and contribute to shaping the technology in all phases [7–11]. The technological development impacts the lives of children and adolescents through play, interaction, learning and communication [12]. This implies that those who work with children and adolescents must have the competence to support innovation in their work [13, 14] including social media management [1]. Utilisation of and competence in social media management may contribute to obtaining an understanding of what children and adolescents are concerned with, and ensure a broad understanding of various circumstances that impact the lives of children and adolescents. This provides opportunities to safeguard the participation of children and adults, whilst at the same time allowing social workers to actively use social media during communication [1]. Despite increased focus in research on how social media can impact children and adolescents, less research has been conducted on students' different use of Facebook and how this can create new innovative learning strategies and opportunities for exercising social work amongst children and adolescents. This research is based on a case study done in Norway, and contributes to more knowledge about innovation within this discipline. The following research question was investigated:

How can social work students' usage of and participation on Facebook create new innovative opportunities for practising social work?

2 Theoretical Frame

For decades the Internet, and use of computers and mobile phones, have been available to a large number of users paving the way for the possibility to experiment with different types of innovations. This includes both the creation and participation in innovation activities. Researchers claims that such development opens the door for new types and forms of innovation [7–9]. The scope of innovations has contributed to knowledge pertaining to why some organisations are innovative and others are not, or why certain innovations can be adopted and others cannot [5, 15]. An innovation has specific characteristics: its usability is acceptably precise, it can be distinguished from other innovations, it is spread 'as is' and individual decisions are made about its application [15]. An innovation can be broadly defined as a process, knowledge or technology that offers something new, 'new to the world' products, but also what a person perceives as newness or 'other unit of adoption' [16:12). The diffusion theory concerns how and why innovations spread, and how and why more people continuously adopt something [17, 18]. This study applies the diffusion theory as a theoretical framework in the way Rogers [15, 16] describes to understand the possibility of expanding the students' innovative knowledge related to children and adolescents through using Facebook. This is a fundamental process that starts out fragile, but is then followed by strong growth, stagnation and the demise of innovation. Diffusion is the process where innovation in the form of an idea, product, application or similar is spread through communication, e.g. on social media platforms, such as Facebook, YouTube, etc., to members of a social system (e.g. students) over a particular length of time. Consequently, diffusion can be defined more generally and theoretically as a phenomenon and also describe other commercial innovations. Three key terms are central to the theoretical definition: (a) channels, (b) members and (c) a social system.

a. Channels describe how an innovation can be conveyed. For example, through marketing, user groups, media and other information channels.
b. Members are generally described as adopters. That is, the people who use, convey or relate to the innovation in any other way.
c. A social system is the network of individuals through whom the innovation is spread. In a commercial context, this often means the business concerned and its own network or the social context in which customers and users revolve.

Five factors are critical to the diffusion process [16]. These distinguish an innovation and are critical to the speed of adoption:

1. Observability: The degree to which a result of an innovation is visible to oneself and others. Visible innovations will spread more rapidly than innovations that are difficult to observe. Diffusion relies on how clear a product can be seen and understood. Information about mobile phones with a good camera or other similar newness spreads quicker because they get the attention of the media more than, for example, a new medicine of great importance to society.
2. Relative advantage: The degree to which an innovation is felt to be better than the idea it will replace. Innovations that have more and better qualities will spread faster than innovations that do not have any beneficial attributes. Diffusion relies on the advantages of the product or process in relation to other products/processes. Mobile phones with features that give access to different types of social media, more cameras, mp3, etc., spread in a different way than products without such features.
3. Complexity: Innovations that are perceived as difficult to understand and hard to use will spread at a slower rate than innovations that are user-friendly and simple. Diffusion depends on how difficult it is to spread the product or service. It has been harder to sell phablets to older users (pensioners) than anticipated.
4. Compatibility: If an innovation is perceived to be compatible with existing values, earlier experiences and the needs of potential adopters, it will probably spread faster than if it is more difficult to associate the innovation with earlier experiences and existing attitudes. Norms, ability and skills - diffusion relies on customers having the norms, skills and ability to accept the innovative products. Large headsets have not spread particularly fast because more mobile phone users have used phone earplugs.
5. Trialability: The degree to which an innovation can be tested to try it out on a small scale or within a limited scope to determine whether the innovation is purely a short-term experiment or whether it is here to stay. Diffusion relies on how easy it is to test the new products/processes. It has been easy to sell new models of mobile phones than landline phones because mobile devices are easier to use.

The establishment of new innovative digital networks on Facebook comprised of social work students is an example of a diffusion process. The network can share information about the challenges and opportunities attached to the field of children and adolescents, and involve all students (members), regardless of sex, age and geographical distance. There are many good examples of online learning activities and assessments methods[4]. The use of ICT and digital learning in higher education is a tool for raising the quality of education, focusing especially on the students' learning outcomes. Learning is central, and thoughts and behaviors aimed at obtaining, processing and organizing new material are defines as good learning strategies. Teachers has to include these factors systematic within their own planning of teaching. However, principles of collaborative learning are important for establishing good learning strategies [2], which include acquiring learning strategies and interest in learning, participate a committed community, get to work, enable opportunities in a constructive manner. Collaborating, coordinating and trusting each other is important to include in studies as factors for teachers, in order for the students to learn something for themselves. Such socio-cultural learning bases on theories by emphasizing that learning takes place in a social context and not in a vacuum [3]. Teacher has to be aware that students can have more control over how they learn, and centered on what they should learn when using technology [4]. However, students need to prepare for online learning to get a better learning effect [1]. Research [2] highlight that students need to develop their own approaches and ways to solve problems demanding the learning environment where they have time and space to reflect on their own learning process. Further, students must have access to several ways to interact with content outside the classroom. Then they can choose the learning strategy that best suits them and thus increase learning outcomes [2]. Social work students' usage of and participation on Facebook created new innovative opportunities for practising social work based on three important factors in organizing these online studies:

- Give the students the chance to use the most appropriate learning strategy.
- When introducing new subject matter, progression should be carefully structure and efforts must be made to make sense.
- Allow students to reflect on their own learning processes together with other students through a review of each other.

Teachers' must offer a broad teaching repertoire where their own digital skills often becomes critical related to the students' learning outcomes in the digital learning processes, which are used[5].

3 Methodology in the Research

The question was investigated through a qualitative case study on 16 Bachelor's Degree students practising social work in Norway for a period of one year. The qualitative method is characterised by direct contact between the researcher and the study participants [19–21]. The role of the researcher was an observer in the classroom

[4] https://utdanningsforskning.no/.

[5] https://utdanningsforskning.no/artikler/utdanningsledelse-og-digitale-laringsformer-i-hoyere-utdanning/.

and among the students. By investigating the qualities linked to groups and networks on Facebook as a communication channel, and how rapidly ICT happens when students interact and communicate with each other, the students' innovative usage was analysed and connected to social work. Implementation of the survey is mainly based on observation of the students' use of Facebook in learning situations and furthermore, it has been examined how quickly this took place through collaboration between students. Based on this, the interpretations are highly significant [20]. The respondents vary in age and originate from different parts of the country. Factors, such as family, finances, earlier education, work experience, etc., were not taken into consideration during the study. The study is limited in the sense that it only provides an indication of how the respondents use Facebook, the learning outcome, whilst uncovering the innovation that consequently resulted. At the same time, factors related to how this innovation then paves the way for new social work solutions are uncovered. The students were specifically observed when using social media to uncover the types of opportunities and challenges that may arise through the innovation. The study relates to information and communication in groups and networks on Facebook in the form of a communication channel, thereafter the rapidity of this via inter-student interaction was examined. The findings were analysed related to diffusion theory [16]. Prior to the start of the study, the interviewees were informed that participation in the study was voluntary, and as such they could withdraw from observations and interviews at any given time without giving a reason. Implementation of the survey follows national guidelines for research and ethics. Observations were conducted for a period of 22 h prior to and during classes in the study programme. Both open and participating observations were selected to observe the students' situation. To validate the observations, notes about the lesson were presented to five interviewees during one of the breaks. This allowed them to read and to distinguish between what they had heard and seen, regardless the interpretation, because they had participated in the lesson themselves. This type of review can support the interpretation and acknowledgement of the interviewee [20]. The following is an example of the reproduced notes that were shown to two out of five students:

> *"NN (female) connects to Facebook and immediately goes to the shared group that has been created for the class. Adds information about today's syllabus and topic for the lesson. Checks the students' shared group and then continues to the last events on her profile."*

> *"NN (female) asks the lecturer the following: "Is there a code of conduct for social media?" She Googles 'code of conduct for social media' on the computer and several hits come up. She quickly checks various links before searching for Facebook and then goes immediately to the students' shared group. Here she puts the same question to the rest of the group and thereafter goes to the last events on her own profile before returning to the discussion in the class."*

Facebook is a factor that can be connected to diffusion and the communication channel component. Also, social work students in the form of a group is a factor that can be connected to diffusion and the social system component. Observation shows how they handled the opportunity social media offers for innovation. An interview user guide containing different types of keywords to obtain information about various circumstances surrounding the use of social media and the innovation such usage presented. The interview guide was given to the students upon commencement of the observation. Nominal data were collected pertaining to sex, age and the number of hours spent using social media. The study's research question, quality, relevance of the empirical data and the researcher's ambitions in terms of transferability or external validity determine how large the sample should be [22: 38]. The transferability threshold for the results of this study is, among others, aimed at the relationship between sex, as there was only one male in the group. Nevertheless, it is important to note that this data material cannot be used to suggest anything about how the same circumstances apply in general to all social work students at universities and university colleges in Norway. It is possible that the phenomenon investigated here varies geographically or from college to college.

3.1 Using Facebook in Connection with the Diffusion Process

All the social work students actively used shared groups on Facebook during all types of instruction. The students used a shared group for their class, which was established by a student at the start of studies, but it could be shut down upon completion of their course. The group's topic was the course subjects and the students gave feedback on various parts of the content. This was done in the form of written feedback consisting of 'like/don't like' buttons, but also new links to similar content about the topic. Information was published about pages on the syllabus applicable to the supervised professional training part of the course that the students would be completing later in the semester. All the students had the 'same' information and some had linked URL addresses to relevant information online. A total of 14 students published information in the shared group, which discussed several topics multiple times. One topic was financial frameworks in the social services. All the students believed that cost-cutting measures were a contributory factor to social workers falling ill because of pressure at work. The final conclusion of the discussion was that social work management teams needed to be clearer when justifying why resources are actually needed and in return hopefully receive what is needed. In relation to Rogers' [16] factor of observability being essential to the diffusion process, the network, in the sense of innovation, is visible to all the members as well as others. Even though this was a small network, it was visible and included all the students. The diffusion theory shows how the network clearly sparks interest and is understood owing to its visibility on social media. This also applies to other similar networks. All information rapidly spreads because the members contribute towards doing this themselves. The factor of trialability also shows that network innovation can be tested to try it out on a small scale or within a limited scope. In this case, network innovation is only a short-term experiment. The diffusion clearly verifies that testing relies on how easy it is to test new digital solutions. A strong contributory factor for ease of use is the utilisation of different types of technological tools, such as computers, mobile phones and tablets. This can also be linked to the factor of relative advantage, as the network innovation has better qualities that enable it to spread more rapidly than innovations with no attributive advantages. Mobile phones with features that give access to different types of social media may contribute to spreading the network in a different way than physical networks without such features. Nevertheless, it is important to note the complexity of innovations, as the solutions or products can be perceived as difficult to understand and to use. Such innovations will spread slower than innovations that are simple and user-friendly. The diffusion depends on how difficult it is to spread the product or service [16]. Privacy and ethics on social media was another topic that was highly discussed. Four students particularly discussed the use of mobile phones and other technology. They were concerned with the fact that as professionals they were responsible for what was written in reports and other documents, and that they needed to be more self-aware when using technology. Everyone was concerned with the fact that they should ask people for their permission to take and share pictures on social media (or use them in any other way) more often than what they do. One female student wrote:

> *"So many people take pictures in all types of situations without considering who they are actually publishing a picture of!"*

Another student wrote:

> *"It's filled with selfies - people don't always think about what's in the background and whether anyone's standing there."*

Those who responded to these posts agreed that it is essential to obtain informed consent in order to safeguard justified representation of other people on social media. The students were particularly concerned with being consciously aware of sharing pictures of children, including their own. The discussion also addressed the matter of talking to other parents or guardians, and the importance of listening to what children want and respecting their own opinions. One student wrote the following:

> *"Everyone has a huge responsibility when it comes to talking about ethics on social media. This applies to students, schools and workplaces, especially in terms of using media to publish accurate information. Perhaps it could contribute towards quality assuring social work? We must think about the way we talk and share information - everywhere on Facebook."*

In addition, another student wrote:

> *"One-year-olds understand that it's possible to talk on a mobile phone, therefore it's obvious that ethical questions surrounding the use of mobile phones, etc., must be discussed."*

Another student in the Facebook group wrote:

> *"The technology isn't exactly going to disappear, but that's not the problem. In my view, there's a lack of understanding surrounding the implementation of changes, or more precisely, talk about how the use of social media changes things in a workplace - where ethical guidelines should be a topic. I found, after my supervised professional training, that it is not a topic at all. In my opinion, this shows that managers don't have the competence to use social media and accept changes at several levels. Furthermore, no managers seek this type of competence to organise it well enough. Social media has at least changed the way I communicate."*

A third student responded quickly to this post:

> *"Of course! I completely agree!! I use fb everyday to communicate and get information. I sell and buy things on fb. I'm a member of parent groups for my children, and training groups where we arrange the time and place for various training activities. As a student, I'm also active in several groups related to becoming a child welfare officer. I'm a member of our first-year class group, and member of groups for the child's best interests and user impact, etc. Through these fb groups, I've received a lot of information about child welfare that I haven't*

> *yet learnt on the course or through supervised professional training. It isn't the case that social media will disappear from child welfare education just by shutting your eyes and ignoring."*

The discussion on ethical challenges continued everyday throughout the week. The most active students then decided to create a Facebook group to share their conclusions with all other social workers interested in the same topic. Only one week after the creation of the group, it almost had 100 members. The students responsible for the group chose to shut it down after a period of six months, just before the end of the semester. The reason being that it demanded too much work to quality assure all comments and opinions that were published and posted. At the same time as this decision was made, there was tremendous focus in the media about various sides of social work in Norway's largest newspapers, both online and in the paper versions.

This also verifies the critical factors in the diffusion process. This example shows that even though the network is not a product with revolutionary knowledge about children and adolescents, it is a digital solution that solves the challenge of obtaining updated information about existing ethical challenges and problems. The network and digital solution on social media contributes to innovative opportunities, because the users are relatively young. With the aid of social media, they addressed ethics and had a remarkable ability to convey and distribute their message in a network, which is critical to the rapidity of adoption. The students perceived the network as compatible with their existing values, earlier experiences and the needs of potential new members; as a result it spread quickly. The diffusion verifies that the innovation relies on the students having norms, skills and the ability to accept the network as a digital solution. The observation demonstrated that all students actively used mobile phones during a class and at break times. Facebook was also used many times during classes. Several of the social media platforms also offer the option of live conversation (two-way communication), but such usage was not observed. During the interviews, I wanted the students to give feedback on what they found challenging when using social media, and whether the challenges could have an impact on their learning processes. All the students pointed out that the media, with the largest national newspapers in the forefront, adversely emphasise the negative sides of the child welfare service and child welfare cases in many ways. Furthermore, they indicated that they would use social media platforms, such as Facebook and various Facebook groups, to seek help and support. All the students stressed that it is crucial to feel safe and confident in these groups. When interviewed, one of the students said the following:

> *"I have become more aware of ethical challenges related to the job I will be doing. It's great that the group addresses ethical challenges in social work. I often discuss what I read with co-students and feel that I become more aware of how to act as a professional."*

The relative advantage factor is also critical to the diffusion process. Students perceive network innovation as a solution with better qualities than, for example, joint physical meetings about the topic. Thus, the innovation spreads more rapidly than innovations with no attributive advantages. This also applies to the complexity factor. The students find Facebook easy to use, simple and user-friendly. Therefore, the service is easy to handle. Awareness when using technology will be a key factor in shaping strategies that can safeguard the participation of both children and adults. In this regard, social services can actively contribute towards facilitation, so that children and adolescents can use social media to communicate with social workers. Here it is important to create good cooperation with parents and other guardians. The students pointed out that this type of cooperation relies on having the skills to use social media. Arrangements could particularly be made in the social services to handle parental contact when children find it stressful and difficult to deal with. Another student described it this way:

> *"This group has meant so much to me…For me, this group has been crucial, as I can ask for advice about things I'm wondering about. Those who have responded have been very professional and connect most of their answers to child welfare legislation. At the same time, it's been great having a group to discuss child welfare with. Obviously, it's good to have someone to ask when you don't have much experience with various things."*

Several of the students said that much of the collaboration connected to their studies was conducted on Facebook. This form of collaboration was natural for the students and they used their network actively. In the interviews, the students said they were conscious of who they contact in relation to the purpose of the contact. When interviewed, one student said:

> *"I'm very conscious of sending private messages, if I don't want everyone to see what I'm writing. Unfortunately, not everyone understands this well enough. It isn't always possible to understand how technology works, for example, how everyone can see what is written or a child showing sexual images of him/herself. That is, the consequences of it - the negative being that it is easier to sexually abuse children and adolescents. However, it can also be used to 'get' the people behind it."*

Members of the Facebook group discussed the challenges connected to social media, the publishing of images of children, social workers, etc. The students highlighted privacy and regulation of the duty of confidentiality when using social media, for example, when children in foster homes find their parents on Facebook and establish contact. What do you do when you discover this as an ordinary user of Facebook, but work as a social worker the next day? What do you do when you find extremely negative comments on Facebook from parents of children under the supervision of the child welfare service? One student wrote the following in the group:

> *"It's incredibly easy to find people at fb. One search and you have found the one you are looking for. You realize that it's hard to hide if you're on fb."*

Another student wrote:

> *"Dependency on being 'active' on social media platforms is sick. The pressure it creates amongst all groups can be very destructive. However, there are also a lot of benefits in the form of sharing and maintaining contact with friends and family who live far away from home. In relation to work, the media contributes to exacerbating the negative sides of the child welfare service. Nevertheless, it's also possible to use the Internet for reading and searching without having to physically ask. In terms of working with child welfare, guidelines should be created to distinguish between one's private and professional life. It's also important to use the professional groups to share and receive information. This could be a good 'support' when confronted with challenging situations."*

The shared group was created for this class only, as such the members were only students and teachers. Everyone could create and give feedback on the content. All the students were also members of different open social work group: 'Professional Group for Child Welfare' or 'Child Welfare Officer' etc. Such openness made it possible to publish posts or give feedback. Often the students posted links to other content, which resulted in something similar to bonding.

4 Analyzing

The analysis of the diffusion process is based on five factors [16] that will result in adoption of an innovation. The diffusion describes the characteristics of the actual innovation; the newness the students created. In this respect, the innovation could be various factors: an idea, a practice, an approach or object. Some of the students had an idea about establishing a shared digital network for the discipline of social work. This changed the practice for how information and communication were both exchanged. The receiver, the other students, perceived these factors as new both individually and as a group/students. These factors are different and therefore have different features as well. The features or uniqueness of the innovation determines how rapid the innovation will be adopted. The diffusion process largely concerns communication. For the students, the communication was about transferring a message from a student (sender) to another person (receiver), and that this form of communication and information exchange resulted in the adoption of the innovation. The study shows how social work students' usage of and participation in social media can create new innovations through the establishment and utilisation of new networks on Facebook. The topic of the networks was social work. More awareness of this could provide better opportunities for practising social work and contribute towards building a knowledge base that also gives access to competence within the field. The social services must be challenged to be more open to innovation and new initiatives from employees, both within and outside the core areas of social work. This would contribute towards more rapid and better results than in services where changes are less common. Mass media is an important communication channel for creating awareness and knowledge about the innovation [16]. Despite this, the analysis shows that interpersonal communication is the most important communication type for changing attitudes and behaviour. This will determine whether the student (receiver) will reject or adopt the innovation. The reason for this is that most people do not base their choices on research or expert statements, but on the subjective evaluations of close friends, co-students, colleagues, etc., who have adopted the innovation. Communication channels enable information and knowledge about the innovation to be distributed to the public. During this process, people create and share their knowledge with each other. By communication channel it is meant the way information is transferred from one person to another to create a shared perception. Social media is an important communication channel for creating knowledge about new innovations [16]. Even communication in the form of online chats about goods, products, methods, etc., on social media influences the attitudes and behaviour of the participants.

The participants will not base their acceptance of new innovations on expert statements and research, but on subjective opinions from the participants' networks, for example, family, friends and colleagues [16]. Social media platforms, for example, Facebook are therefore important communication channels where the participants can express their opinions and views publicly or in closed groups. Communication is the constant factor. The development of social media creates more room for interaction and collaboration. More citizens now take part in political debates online. That is, social media influences social engagement, democratic participation and freedom of information [23]. The time aspect and speed during the communication process related to newness and diffusion theory is about the decision-making process to adopt or reject the innovation. If a social work student, for example, wants to become a member of an open Facebook group, the student must obtain information about the group (the innovation) several times before deciding whether to become a member of the group. An example is when some of the students I observed created a group for the class about the Norwegian Child Welfare Act. The objective was to discuss law amendments connected to the implementation of a new child welfare services act. If the other students show little or no interest in discussing this, the group will not be very active when it comes to sharing information and it will probably be shut down after a while. Sometimes groups are created for a particular purpose, for example, in connection with academic conferences, seminars, meetings. When the activity is over, the group may be deleted. The decision-making process is about how early new innovations can be adopted in relation to other individuals or groups/organisations [16]. For example, information via social media will immediately reach a tremendous amount of people in contrast to newspapers, journals, flyers and other publications. The decision to adopt or reject an innovation takes time, because potential users gather information several times to make sure they are making the right decision about the innovation. Based on this, Rogers [16] divides the population into five different categories according to have rapidly they adopt the innovation in relation to others.

1. Innovators: characterised as bold, curious, risk takers with a low threshold for testing and adopting innovations.
2. Early adopters: also characterised as interested in new innovations, but do not take as many risks as the innovators.
3. Critical mass: the early majority who make up the critical mass. If the innovation is successfully adopted here, spreading to the rest of the population is unlikely. This category is characterised as cautious. In general they are not leaders and are slower at adopting innovations. Critical mass is understood to be the point in a spreading process when enough individuals have adopted an innovation
4. Sceptics: the late majority accepts and adopts new innovations later than the most people in a system. These are characterised as sceptics and approach the adoption of innovations with high scepticism (especially a financial risk).
5. Laggards appear to be very traditional. These have a limited image and interest in the world, newness and the unfamiliar. Their point of reference lies in the past and local community. By the time laggards adopt new innovations, developments have probably gone a step further with new innovations.

This categorisation can also be applied to the student group and each student's use of the innovative digital network. All the students are part of a social system where they interact and communicate with each other. A social system can be described as interconnected members/entities engaged in solving a shared problem with a common goal in mind. Members or entities can be people, informal groups, organisations or sub-groups/systems. There are various roles in the social systems and these either push forward, control/manage, delay or stop the diffusion process. The role of innovator is critical in order for an innovation to be created, but it is not essential for the actual diffusion process. Social systems create boundaries [24]. The roll of opinion leader is vital to the diffusion process [16]. An opinion leader holds high status in his/her social system and must comply with the norms in the system. Norms are the established behavioural patterns in these social systems, and are significant to diffusion. Opinion leaders are described as more extroverted than their followers and are likely to express themselves on social media and have a stronghold in the communication network. Agents of change tend to have higher education and a professional background for the ideas they are trying to spread on behalf of an organisation. This group normally has to go through opinion leaders in order to be successful, but they can also use helpers who are familiar with the social worker's (target group's) environment, language and culture. The students were online most of the time over a 24-hour period mostly on social media communicating with family, friends and network building. Groups and networks on social media change quickly. The students' establishment of new network groups on Facebook correspond with the description of an innovation [15, 16]. The digital network is a solution with a clearly defined target group. Since the target group is quite small, it will be easy for all potential users to adopt and use. The critical factor is that those who first adopt new technology have high social status and a strong influence. Innovators, the initial adopters, talk about the new innovation to friends and acquaintances who in turn become adopters and talk about it to their friends. A social system is defined as an ordered, demarcated pattern of human beings interacting with each other [25: 287]. When groups are analysed as social systems it means that the role of the participants are mutually defined in relation to each other [16, 24]. Consequently, the roles towards each other change, and are formed and developed during dynamic interaction, whereby the role of one participant impacts the outcome of the role of other participant.

The study showed that several of the social work students gathered information about the different professional groups before deciding whether to join. Awareness surrounding when and how the use of social media is valuable to social work is important in this process to enable social work students to exploit the potential that lies within these resources. In addition to being able to describe Facebook groups as innovations, the members of the groups also correspond to the description of a social system where social work students interact and communicate with each other [16].

5 Discussion

The establishment of new networks for social work students on Facebook concerns a new generation of Internet users and a new user pattern where students share academic-specific content, opinions, information, experiences and knowledge, etc. The network and group are therefore user-controlled. During the study several of the social work students expressed that they felt incapable of building networks. More focus must therefore be placed on the acquisition of such competence in the education programme. At the same time, competence enhancement is also necessary in the programme, as well as the discipline under which the use of social media falls. The study showed that the students want to use social media more, especially Facebook, in education programmes, as well as social work. The students said they believe they have something to contribute with in terms of exploiting the manoeuvrability these resources offer. Facebook as a communication channel enables information and knowledge about the innovation to be distributed to the public [16]. Even communication in the form of, for example, online chats about social services influences the attitudes and behaviour of the participants. During the study, the students talked about situations connected to communication between children and parents that children could perceive as difficult. Adolescents experience pressure from their parents through social media. The students believed it was crucial to develop good parental cooperation. However, the challenge was to organise the type of contact that would protect and shield the child when necessary. When meeting children and adolescents in crisis situations, the critical factors include how you behave as an adult, and what you can and want to contribute with. For this type of work, use of social media may also be an important factor in understanding what children and adolescents are concerned with. In addition, social workers may obtain more knowledge about what influences the lives of children and adolescents. Several students in the social work students' Facebook group led the various discussions. These innovators informally influenced the others in the group to change their attitudes towards the team that was being discussed. In the long-term, such situations could change social work. This type of activity is compatible with communication in diffusion theory [16].

Communication can fundamentally be described as social, whereby intellectual development, thinking and learning occurs during social activity with others. Good communication is a prerequisite for outstanding social work and the ability to communicate can be trained and developed [26]. By exploiting the habits of students and their use of social media, it is possible to facilitate new methods of communication and learning that could lead to changes in social services. An example is new opportunities for safeguarding the participation of children and adults. The use of social media paves the way for innovation where new networks and groups can be established with emphasis on facilitation, to allow the user experience and training to take place in safe and more organised forms than traditional social media. Nevertheless, important user competence must be easy to transfer between the various types of media. This is challenging, as contact through social media cannot be regulated. Accessibility and information related to social work are factors that several students described as future challenges they expected to be able to handle. Social media enables one to be creative and innovative in order to find new ways of getting the attention of users. In addition, social media facilitates dialogue between the users and user groups. At the same time, social media is oral and informal so some users may perceive it as a barrier when conveying a message. There are also restrictions on access to information and communication if the user does not already have a relationship with relevant people 'inside' the group. The decision-making process attached to diffusion theory concerns the decision-making processing in terms of whether to adopt or reject the innovation. If the members of the group are followers of the activity in the group, more people will use the group. Social media makes it is easy to observe activity, what is published, which posts create engagement and which do not. Information is the key in education and learning. It is important to give teachers room to explore digitalisation, contribute to education and facilitate new research results. By using social media, students, teachers, researchers and employees during supervised professional training (if applicable) can obtain innovative advantages. It is important that education institutions exploit the manoeuvrability that develops when taking social media into use. They can organise and apply knowledge through new social media network groups. This complies with the description of the decision-making process pertaining to how early new innovations can be adopted in relation to other individuals or groups/organisations [16].

The study shows that students believe they will probably use social media in their professional lives as social workers in the future. Nevertheless, the challenges associated with using social media paves the way for better cooperation in general. Cooperation could also facilitate collaboration with children, adolescents and/or parents about other matters. Through more training on social media for professional use, the students will to be able to further exploit the manoeuvrability that arises from using the social media platforms they already use. One of the challenges of social media in general is the huge amount of information available. It is necessary to be aware of who is conveying what and where, and the type of information that is presented within various social fields. This also corresponds with earlier research [23]. The digital networks and cooperation resulted in innovation, creativity and competence enhancement. This is extremely important for the further development of the students in their training as social workers, so they can cooperate with other professions and put innovation back into the field again. The introduction of digital solutions into the study programme contributed towards spreading knowledge about the use of technology in social work. In this way, the innovation contributes to cultivation of the competence social workers will need in years to come. Social work is a female-dominated occupation. The development of digital networks will contribute towards forums for women in occupations involving children and adolescents. This will help reinforce unity and network building for women in the occupation and provide inspiration for more women to be employed in leading positions in both private and state-owned companies, and organisations.

The study shows how the social work students' use of and participation on Facebook created something new, an innovative network. This contributes towards showing that knowledge about the use of social media can help develop more awareness about communication, information, cooperation and new working methods. In turn, this can develop better understanding of the interests and influence of children, adolescents, parents and foster parents, and more active participation and cooperation at different levels in social work. The social work students became more engaged in topics about the field they would be working in. Through joint assignments, the learning process became more student-centred and they were more their own teacher in that they acquired knowledge by drawing on other students through virtual collaboration. Educational institutions must create work methods built on collaboration and collective action. Teachers and researchers could be in networks with other teachers and researchers, share ideas, experiences and best practices, research results, be open to new technology, new teaching methods and research areas. To make the learning process more interesting, it is necessary to use social media platforms that contribute to the creation of social interaction, and which make sharing easier and pave the way for new manoeuvrability and innovations. Universities and university colleges play a vital role in society through training highly qualified candidates. Pedagogical digitalisation must especially be enhanced to a strategic level to make it possible to implement unified measures for digitalisation of the learning processes. This must be facilitated for flexible and efficient study programmes and for collaborative learning in close interaction with co-students and teachers. It is important for social work students to have access to a modern and personal learning environment with possibilities for individual learning plans. However, subjects such as technology and social media usage should be included in the studies.

6 Conclusion

Social media in the way it organised today challenges the social services. The social services must gain better insight into the expectations of the educational field. Through closer cooperation between the field and social work education, both will obtain more insight into the challenges and opportunities in each field. This could contribute to more cooperation. Open social media platforms will create new opportunities for initiating participation in social work. Relationships between future social workers are influenced through communication on social media. The same applies to relationships between social workers and their users. Awareness when using technology will be a key factor in shaping strategies that can safeguard the participation of both children and adults. In this respect, social services can actively contribute towards facilitation, so that children and adolescents can use social media to communicate with social workers. Here it is important to create good cooperation with parents and other guardians. Innovation that provides opportunities for new activities clarifies ethical issues, such as privacy and management of the duty of confidentiality in communication between social workers and children, adolescents and families. The use of social network communities related to social work education should be included as a more defined topic in research on social work. This type of social change contributes towards innovation in social work and may result in better solutions for communication and more efficiency, etc., but also knowhow about reinforcing change. This will probably induce other ways to provide services and to communicate in social work. In this chapter it is argued that social work students use of Facebook reveals various challenges and opportunities that may be relevant to social work in the future. Knowledge about and competence on how to use social media should therefore be related to theory and supervised professional training during the course of study. This investigation contributes towards underpinning the importance of more research on the topic.

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Between Research and Action: The Generative Sense of Technology

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Abstract. Web search and the consequent possibility of accessing billions of documents, with relative ease, is now an important resource for students in the learning process. But what seems to prefigure a new era in sharing knowledge risks remaining a utopia for dyslexic students. This paper presents an educational experience based on the use of Instagram to create a "visual" search engine where the search results are shown through images (and not just words) that represent the educational mediator to recall content related to specific concepts. The affordances of this tool and its educational implications are analysed (highlighting their potential and threats) in order to develop appropriate actions for this new learning environment.

Keywords: Affordance · Dyslexia · Instagram · Learning · Motivation

1 Introduction

In contemporary society the forms of knowledge and consequently the modalities of access to information are changing rapidly.

The explosion of information made available by the Internet is an obvious fact: sources, supports, channels and information and communication tools are multiplying all the time. However, if the Web has allowed immediate access to interpersonal resources (e-mail, forums), bibliographic resources (online catalogs or e-books) and documentary resources (web pages), in the same way it has not yet been able to provide innovative ways to improve access to information.

On the one hand, the search engine is now a tool to facilitate access to this huge amount of data, even if doing an effective search (able to identify exactly what the user wants to find) is not at all simple. On the other hand, the results of this research can be presented as a little homogeneous and disorganized information: it is often also difficult to establish the degree of reliability of the information found on the net, with the risk of having erroneous information or in part. The results of the research for a dyslexic person present another obstacle [1, 2]: these are presented as a textual list of possible sites and for dyslexia reading is a difficulty that can severely limit access to information.

In the didactic field, nowadays the search for information on the Internet by the students, while they are studying, is a usual activity [3], almost taken for granted, which derives in whole or in part from the structure of the lesson in the classroom.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 754–763, 2019.
https://doi.org/10.1007/978-3-030-35343-8_78

Technologies are an important tool for the teacher who is increasingly having to work with heterogeneous classes in which the students have behavioral modalities, linguistic abilities, personal characteristics (previous experiences, motivation) and different levels of learning [4].

Teaching all the students of a class the same subject related to a discipline requires special attention from the teacher. Applications are needed that take into account each student in the personal and school situation in which he finds himself at that precise moment. In the case of dyslexic students, it is necessary to proceed by limiting the use of some techniques (reading or writing or calculation), searching for different methods and channels to convey the same proposals, graduating the presentation of the contents to keep under control the fatigue that is often found in the students with this disorder and that must not exceed a certain threshold. Therefore, the characteristics of inclusive work are those that will bring all the students of the class group to find their own space within the teacher's proposal, to complete the task in a personal way and to achieve the ability provided in the field of relative knowledge to the competence that represents the final goal to reach, with satisfaction for what has been achieved [5]. Therefore, the main key of inclusion can be summarized in: acceptance and enhancement of diversity, consideration of the other and enhancement of each, active participation, collaborative work, promotion of change [6].

Naturally the introduction of technologies in teaching does not automatically guarantee an improvement in the quality of teaching [7]. The technologies are not in fact a "new certainty" but represent a "possibility". The fundamental question to be able to start thinking constructively about information and communication technologies in the field of teaching is to design activities, combining some context variables with formal learning paths, directing them towards goals coherent with the process educational [8].

This article presents a case study referred to a Music Technologies (MT) teaching project developed in a Music High School. The project involved 77 students, including 5 dyslexic students, attending the second, fourth and fifth year. The purpose of this project was to create a sort of search engine using the Instagram Social Network. The students were engaged in developing a database within Instagram, relating to specific terms and concepts explained during the classroom lessons (or related to them), associating each of them with a specific image (which represented the didactic mediator to recall content related to the concept), tags and a guiding text. Since the keywords are the basis of the search engine's operation, much emphasis was placed during the project: on the correct use of these words and on their identification within a text; on the methods/criteria for identifying/choosing the image to be associated with a topic; on choosing the font to use for the text.

This paper is organized as follows.

Section 2 analysis the concept of "didactic" between research and action. Section 3 describes the Social Network Instagram. This is followed by a description of the strengths and opportunity that Instagram offers. Section 4 shows an experimental test that illustrate the effectiveness of the proposed method. Finally, in Sect. 5 the paper ends with concluding remarks on the current issues and future research possibilities with respect to the efficient enhancement of educational practices and technologies.

2 Research and Action in Teaching

The object of teaching is the teaching that aims at learning, but does not determine it [9]. The teaching builds favourable conditions for student to learn.

It is important for each teacher to recognize the processes that specify their own discipline and interpret them in light of their educational potential for students. This means considering the cognitive, affective and relational peculiarities of the recipients of the teaching.

Learning is a composite process through which a subject combines new information and knowledge with those he possesses, reconstructing them in new forms and with new meanings. In reality there are many processes that determine learning and each subject prefers their own ways and styles in knowing and learning.

More and more the teacher is working with heterogeneous classes from the learning point of view. The presence of dyslexic students imposes on the teacher certain didactic choices that help such students and that also turn out to be useful for all the other students (the non-dyslexic ones) in order to make didactic practice more efficient, the study method more conscious and the learning more long lasting and more profound [10].

Dyslexia is a combination of strengths and weaknesses, which affect the learning process in reading, spelling, writing and sometimes number and calculation. However, dyslexia should not be considered by the teacher as a learning difficulty, because it would inevitably lead to focus on identifying weaknesses rather than on strengths. The presence of dyslexic students in the classroom must be considered as a resource (rather than an obstacle to didactic action) [11], for the teacher and for all students in general. The non-dyslexic student must know what dyslexia is in order to work with all the classmates.

The teacher must always bear in mind that the field of teaching includes both the scholastic and the extracurricular. Nowadays, all the students use the computer, the smartphone or tablet, to communicate and study during the extra-curricular time. This implies, in most cases, doing internet research. Information seeking involves a variety of cognitive abilities. Spelling skills are necessary to correctly insert the terms [12]. Reading skills and a good working memory are needed when exploring the lists of results and evaluating documents [13]. Many of these abilities are often compromised in dyslexic users and this can have a negative effect on research results.

All these considerations are the basis of the educational project illustrated in this paper. The main aim was to put all students (dyslexic and non-dyslexic students) in a position to use teaching resources specifically related to the topics covered during the course of Music Technologies, in order to solve certain problems related to the design of a stereophonic recording. Each musical event has its own characteristics that differentiate it from other events. We need to consider: the architectural aspects and the acoustics of the place where the recording takes place (in order to define the position of the musicians); the musical instruments involved (and therefore their characteristics of production and emission of the sound); the stylistic interpretation of the pieces, linked to the historical period. There is a need for a plurality of information that often, for educational reasons related to the number of available lesson hours, the teacher treats in a partial or inadequate way, leaving the students to study in depth. Internet research becomes almost essential to have all the information you need to get a good result.

To remedy the possible problems of dyslexic students related to research, it was decided to use the Instagram Social Network as a search engine for the consultation of a database created, internally, by students with the supervision of two specialist tutors (within of dyslexia) and the teachers of Music Technology, History of Music, Art History and foreign language.

3 Why Instagram?

In everyday life, students (but also adults) use Social Media as a communication tool: it is a set of e-platforms used to socialize, share information, and hang out [14]. These platforms provide users a lot of activities for interaction among people, where everybody can share, exchange, comment, discuss and create information and knowledge in a collaborative way [15].

Students might spend their time almost around the clock to use social media via their laptops or mobile devices. They may have their own account to interact with their friends and to have social interaction among people. Therefore, this popularity can be adapted by the teacher to develop certain activities. Teachers can actively use such tools to organize online activities.

Among the Social Networks, each with its own peculiarities, Instagram is the one that seems to attract students the most. It is a platform that allows the sharing of images by also making available a set of filters to act on them: a characteristic that excites students in particular. The benefits of using Instagram in the learning process are as follows:

- possibility to write a caption to explain and contextualize the image;
- possibility to insert hashtags to give value and meaning to an image, making it easier to consult content related to a specific topic;
- possibility to create a public or private profile;
- possibility to create a group (social network group) that supports the social interactions;
- possibility to create an inclusive experience for all students;
- possibility to learn to use a target language;
- possibility to enhance language development;
- possibility to encourage self-expression and spontaneous use of language;
- possibility to insert a (short) video, with a caption and hashtags;
- possibility to upload a maximum of ten photos/videos in a single post, which can be viewed as a slideshow.

On the base of the above considerations, it is possible to identify the potentialities of Instagram regarding the dyslexic student:

- the possibility to see an image help him/her in identifying a topic/concept;
- the conciseness of the messages helps the student who have a hard time reading and it does not tire him/her when learning the content;

- the possibility to write short messages helps him/her to develop the capacity to formulate a question or an answer;
- the possibility to send and watch video messages rather than text messages helps the student who have trouble with reading and/or writing;
- the possibility to watch several times the same video message helps the student to learn.

The challenges that the current society poses can be faced if the teacher succeeds in opening up to social contexts through participation in knowledge-building environments [16], in which common commitment is an important element both for the development of specific competences, and for the transversal ones [17], and also to become a person capable of facing uncertainty, solving problems and developing creative solutions in collaboration with others.

Shared community spaces and communication between groups are the predominant part of what excites young people, contributing to their perseverance and motivation in their studies [18].

4 Application and Analysis: Research Method

The research presented in this paper refers to a project that analyses the effects on learning and on teaching brought by the implementation of the Social Network Instagram in the classroom lesson. The discipline forming the object of the project was Music Technology. The project involved students in a collaborative process of online knowledge creation in a formal context and informal, with the aim of developing their skills in the field of sound event analysis. The laboratory, realized with the project, included the creation of a specific database, composed of images with associated captions and hashtags, to be consulted through Instagram. The Social Network had to replace a normal search engine for identifying information (see paragraph 2). For each concept explained by the teacher in the classroom, a post was created with a short caption concerning the concept (also containing the external link to find information), using an easy and simple language to make the text understandable to everyone (especially to dyslexic students), identifying the appropriate hashtags and the most representative image of the concept.

The laboratory was conducted for a time period of 8 months (from October 2018 to May 2019) and it engaged:

- 52 students in the fourth and fifth grade (G1), who had to create the database,
- 25 students (including 5 dyslexic students) in the second grade (G2), who had to use the database,
- two specialist tutors (in the field of dyslexia),
- the teachers of Music Technology, Music History, Art History and foreign language.

During the first month, the teachers involved in the project carried out the lessons with G2 in the computer lab (set up with a computer for each student), dividing each lesson into two parts: the first dedicated to explanation and the second dedicated to internet research of specific concepts covered in the first part. The goal was to monitor all students and try to assess their research skills. The results from this study were that dyslexic users on average exhibited fewer search iterations, took more time on each search and reviewed fewer documents than the controls. The conclusion was that there is a need for more knowledge on the information searching behaviour of users with dyslexia.

In the following months (from October to May) the laboratory was held in three distinct phases.

In the first phase all the students (G1 + G2) initially filled in a self-assessment questionnaire concerning the use of Instagram, their digital skills and ability in processing an image. Then, G1 followed an introductory course on the topic of Information Literacy (8 h), in order to acquire the skills to refine the identification of keywords within a text. Subsequently he participated in a laboratory in presence (8 h) in which an expert explained to them the importance of images in information and the functions of the image: the image in multimedia communication constitutes a sort of (visual) language that supports and integrates the textual language, it can become a metaphor, a visual allegory that enhances the usability of interactive systems, or reproduces the real concept with exact details.

In the second phase the fourth and fifth year students (G1) were divided into groups, each one consisting of 4 participants, and they freely chose the concepts to be treated (among the concepts explained by the teacher to the students of the second year). Then, the students independently researched the information sources (to refer to the contents) and discussed about the captions, hashtags and images, in a specific forum supervised by the tutors.

In the third phase, after the teachers' approval, G1 published the entries online. Then, they monitored each post on Instagram for about a month to see if there were requests for clarification from other students and trying to improve the content. Finally, they answered a questionnaire on the perception of their experience and on the development of their transversal skills.

The G1 students were the recipients of the project, while the G2 students were the users of the database in order to be able to validate and evaluate the work.

During the music technology lessons, all the concepts related to physical and environmental acoustics, microphones and stereophonic recording techniques were explained at G2 and some examples of Case Study concerning the stereophonic recording of musical events in different situations were illustrated. Five work groups were created, each one made up of 5 students (of which one dyslexic student). After that, the teacher asked them to carry out some case studies with situations that were different from those already explained and without using the Internet to search for information. In this first phase, the goal was to consolidate the concept of "case study" in each student.

Through a self-assessment survey (see Table 1), it was possible to monitor the work of dyslexic students at the level of participation in the work of the group and of autonomy in carrying out the tasks.

Since February 2019, each G2 student has been asked to individually carry out some case studies with situations each time different from those already analysed and using Instagram to search for information (and not the traditional search engines like

Table 1. Excerpt of the self-assessment survey.

At school you get along:	☐ with all the companions ☐ with almost everyone ☐ with a few ☐ with nobody
Do you prefer to work:	☐ alone ☐ with any group of companions ☐ exclusively with a few companions that you consider your friends
In a work group:	☐ you work as an equal ☐ you tend to be the leader ☐ you prefer to follow others
How did you feel in the project activity?	☐ interested ☐ curious ☐ involved ☐ active ☐ autonomous ☐ collaborative with classmates
Problem solving or application activities:	☐ easy ☐ stimulant ☐ appropriate ☐ quite complicated ☐ hard ☐ very difficult
You believe you can successfully participate in:	☐ discussions ☐ research groups ☐ free activity groups
How did you contribute to the discussion in the group:	☐ I didn't cooperate ☐ I worked only marginally ☐ I had difficulty participating like the others ☐ Someone has participated little in the activities ☐ Someone wasted time playing or joking ☐ Listening without intervening ☐ Asking for clarifications ☐ Stimulating the participation of others ☐ Proposing ideas and suggestions ☐ Outlining differences of opinion ☐ Checking the reactions of others ☐ Accepting the reactions and proposals of others ☐ Helping the group achieve the goals ☐ Assuming a precise role (verbalizer, leader, controller, time keeper, …)
…	…

Google, Yahoo …), in which there was a private group with the posts created by G1. Every dyslexic student had the task of: inserting "Like" on posts that were easy to consult and useful for personal purposes; insert a comment to a post in case of criticality so that G1 could intervene and modify the post; communicate to G1 via chat, any terms searched and not found (so that G1 could create new posts). On the whole, the posts present at the end of January were 135 and at the end of the project 214; 32 existing posts were modified.

The chat was also used for communication among G1 members and therefore to monitor their communication and collaborative relationships. Initially, critical issues emerged: the perception of an evaluation of the proposed posts and the consequent uncertainty on the outcome of the publication; the difficulties in creating a post; the difficulties of writing captions and selecting images in collaborative mode and shared by all; the difficulties of relationships among group members. These critical issues have been gradually attenuated since G2 started using the Database and providing feedback.

For G1, the recognized, developed and valued skills that have been taken into consideration are:

- know how to search for sources to be included in captions,
- be able to distinguish between the important and the trivial,
- know how to identify keywords in text in order to create hashtags,
- know how to identify the right image for each post,
- know how to create the caption,
- know how to collaborate to create the database,
- knowing how to respect the rules of interaction between students,
- be aware that the product produced will be useful to other students,
- be able to reprocess the captions already entered,
- be able to consider suggestions from other students,
- understand the concept of copyright to privacy.

For G1, the recognized, developed and valued skills that have been taken into consideration are:

- be able to recognize the problem,
- know how to search for sources (using appropriate keywords),
- knowing how to interpret information,
- knowing how to identify links and relationships between concepts,
- know how to collaborate and participate in the work group,
- knowing how to act autonomously and responsibly,
- be able to learn from experiences acquired in different contexts,
- knowing how to apply the knowledge and skills learned in a variety of contexts,
- knowing how to introduce new ideas,
- be able to distinguish between the important and the trivial.

At the end of the project (May 2019), a gradual improvement was noted in the papers produced by dyslexic students: in their autonomy to perform a task, in the use of technical language, in the analysis of the event and in the identification of points of strength, weakness, opportunities and threats. These improvements also emerged for non-dyslexic students with low academic performance. At the same time, the project was also positive for G1 who were able to improve their knowledge and skills but above all to build and develop those skills considered as "a prerequisite for active (digital) citizenship". Learning is active when the learner increases their knowledge by "doing", that is through the manipulation of objects according to the principle of learning by doing: in this sense Instagram fulfils for this purpose becoming a "cognitive artefact" [19] that is a tool that through its use it allows to constitute mental schemes that "change the status of the subject from a consumer of information to that of a producer of knowledge" [20].

Finally, from the point of view of involvement and motivation, the activity certainly proved to be a success, given that about 40% of G1 students declared that they will continue to create posts on Instagram.

5 Discussion and Conclusions

This article highlights some potentialities of the use of the Social Network (Instagram) in the learning process, emphasizing the need for use by the teacher of effective cognitive and metacognitive strategies. It follows the importance of designing the learning process in a structured but at the same time dynamic way, approaching the participatory culture based on the typical interaction of informal contexts. This interaction between the formal and informal dimension can allow the development of strategies for reworking and cognitive planning and cooperation between equals.

However, networking is not natural and easy. The network spontaneously promotes creative anarchy even if it then allows the development of vital social dynamics and it is therefore necessary to work on rules, roles and timing. It is precisely on this front that technologies can make their contribution. The tools are in fact capable of performing a dual task: offering support for action and helping to revive and strengthen the system of information, constraints and rules.

All this can contribute to create an open, flexible and inclusive learning environment. Inclusivity in the classroom is a key issue, as students come from a diverse range of backgrounds and bring a variety of learning styles, abilities, and experience to each discipline. The presence of dyslexic students becomes for the teacher an opportunity to reflect on his own way of teaching; at the same time, it represents an opportunity to introduce changes in the way of organizing and proposing educational activities attentive to the diversity and peculiarities of each of the students that make up the group.

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Locus of Control and Usage of Social Media on Academic Achievement Among Police College Students in Taiwan

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Abstract. In recent years, owing to the development of mobile devices, people can use social media more conveniently. This new trend of media drastically changes people's lives, especially among adolescents. Earlier researches suggested it benefits their learning performance but also contains the risk of addiction. This research thus investigated the relationship between the usage of social media and the academic achievement of college students, and whether this would be different among students with the various locus of control. There was a total of 298 students participated in this research. The results are as follows: (1) External locus of control on expanding one's conduct grade has several significant positive effects. (2) External locus of control on expressing the usage of social media has several significant positive effects. (3) Conduct grade was directly affected by External locus of control, this connection was the full mediation by the use time of social media. Last but not least, we have some suggestions for teachers, parents, and schools. Since using social media is essential for modern life, the following rise and problems from using social media applications or websites exist too. However, social media should not take the blame entirely. It all depends on how you use it. We should teach students to control themselves and use the right way to get better academic results, rather than getting rid of mobile phones and removing social media applications from their mobile phones. We hope that we can find the proper solutions in the future by having more in-depth research and avoid students' abuse of social media and improve academic achievement.

Keywords: Locus of control · Social media · Academic achievement

1 Introduction

Rotter [1] said, "Locus of control (LOC) refers to the person's belief in the extent of the impact of his behavior on specific outcomes." The learners who are external locus consider their success and failure are mainly due to the external factors, such as chances or toughness of assignment. Those who are internal locus see themselves as the key

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 764–771, 2019.
https://doi.org/10.1007/978-3-030-35343-8_79

factor of their success. In the classroom, more questions would be asked by internal locus learners to facilitate their learning performance, and they appear to be more considerate during a team-working situation to the group.

Taiwan is one of the countries with the highest penetration rate of social media, like South Korea and Singapore. [2] These days, most Taiwanese social media users were signed-in via their mobile phones.

Due to the specific age and mental condition of adolescents, it is widely considered that they are the main victim of using mobile phones and social networks [3].

The use of social media by adolescents and youth affects all aspects of their lives. However, there were only a few in-depth studies on the impact of these networks' indifferent social and psychological aspects, especially the relationship between the internal and external LOC, the use of social media, and the academic performance of students. Hence, the present research intends to give a response to this question "what's the relationship between LOC, the usage of social media and students' academic achievement?".

2 Literature Review

2.1 Internal – External Locus of Control

"Locus of control refers to the person's belief in the extent of the impact of his behavior on specific outcomes." [1] A large facet of influence is based on whether a person thinks they are capable of controlling the situation or not, their belief toward the factors which cause anticipated results in his or her life.

Rotter defined external and internal control of reinforcement as follows: "When reinforcement is perceived by the subject as following some action of his own but not being entirely contingent upon his action, then, in our culture, it is typically perceived as being a result of luck, chance, fate, as under the control of powerful others, or as unpredictable because of the great complexity of the forces surrounding him."

"External control is labeled when the event is interpreted in this way by an individual. On the other hand, If the person perceives that the event is contingent upon one's own behavior or one's own relatively permanent characteristics, we define this a belief as internal control" [4].

Therefore, college students with a stronger internal LOC may think that their achievements were obtained through their abilities and efforts, while other students with a strong external LOC may think that their achievements are the result of bad or good luck or just the person who designs the bad tests or grades capriciously.

Locus of Control and Academic Achievement

Major literature reviews showed that internals and externals differed in numerous ways, particularly in terms of their cognitive activity and environmental mastery. Because they are more perceptive of their situations, internals seems to exert more control over their lives in part by their knowledge of their environments [5].

Intuitively, students who attribute success to internal factors may expect success in the future; students who attribute failure to internal factors may expect failure in the future unless they believe they are capable of addressing these factors actively instead.

Success is attributed to external factors that are more likely to make their success unpredictable, so they believe that students are powerless and unable to address what they believe to be uncontrollable.

Within the domain of education, internal control has been found to be a positive predictor of academic achievement [6] and external control to be a negative predictor of academic achievement [7]. The relationship between LOC and academic achievement is convoluted. One study found that if a purpose for the assignment is given, externals tend to do better on a task than internals [8].

When predictions are based solely on the academic trajectory of control, Simon [9] cannot predict academic achievement. Even though all studies have not found that control sources unilaterally affect academic performance, some studies have found that control sources may have an indirect effect on academic performance.

Janssen and Carton [10] found that college students with internal control sources are not as procrastinators as students with external sources of control, no matter how difficult the task is. Dollinger [11] found that internal factors are superior to external factors in the knowledge of class trivial information related to academic achievement.

2.2 Social Media

Social media, or "user-generated content utilizing Internet-based publishing technologies, distinct from traditional print and broadcast media," [12] has become popular in professional, personal and promotional uses. Social media is used to connect with friends, colleagues, and family and to communicate in both directions [12]. Social media offers a range of tools for connecting people and sharing content, such as social networking sites (such as Facebook and Line), photo sharing sites (such as Instagram), and video sharing sites (such as YouTube).

Social media is unique in that it promotes two-way communication, enabling organizations to personalize content and interact with the community and the public, as compared to other types of print and broadcast media. Customizing and personalizing health information through social media can increase the relevance of information distribution and increase recipients' attention to communication.

Social media penetration based on active users of the top social networks in each country compared to the total population in Taiwan is 89% (the 2nd in the world). The average amount of time per day spent using social media via any device in Taiwan is 1:52 (in hours and minutes) [2].

As mentioned above, we can summarize: Internal and external sources of control are positive/negative predictors of academic achievement. Social media is unique because it promotes two-way communication. It can increase interaction between students and teachers or peers and improve learning efficiency. In contrast, social media abuse may lead to a decline in academic performance. We propose our research questions below:

1. How does Internal or external LOC affect academic performance?
2. How does the usage of social media affect academic performance?
3. The connection between locus of control, social media usage, and academic achievement?

3 Method

3.1 Participants and Procedures

A total of 298 Taiwan Police College students participated in this survey. The participants were from the first (47.3%) and second grade (52.7%). Among them, 30.5% were female, and 69.5% were male. The average age is 20.22 years old (SD = 1.6).

This correlational study employed statistical methods to analyze the student data gathered from the LOC survey [1], student's academic record, conduct grade, and social media use to determine the relationship between the frequency of social media usage, student academic achievement, and locus of control. The participants accessed the survey via a link through a Line or Dcard invitation. That link took them to the SurveyCake website. This survey measured the student's LOC level and the time they spend on social media. The student‘s Academic Achievement including academic record and conduct grade were all collected from the college. After completing the survey, they were given the chance to win a convenience store gift certificate (selected by random).

3.2 Instrument

Rotter's Locus of Control Scale. The scale was designed by Rotter in 1955 and is based on his doctoral thesis of two students. The internal and external sites of the control scale consisted of 29 items, each of which had a problem, that is, the internal or external control score was 23 pairs, and 6 items were designed to conceal the purpose of the scale.

Social Media Usage Inventory. To assess students' usage toward social media, we developed "Social media usage Inventory". It has 6 items such as: "How many hours do you use social media per day?" and "Which social media do you use most often?"

Student's Score Average. Student's average score in their first and second year was used individually for the measurement of educational achievement.

3.3 Data Analysis

We used Statistical Package for Social Scientists (SPSS 23) for Windows to analyze our data. Chi-square and ANOVA were used to determine the difference and relationship between LOC and other variables. We also used PROCESS 2.x to evaluate the mediation effect of social media usage between LOC and academic achievement [14].

4 Results

4.1 Descriptive Statistics

Among the 298 students, 103 students were internal control (34.6%) and 195 students were external control (65.4%). Their social media usage time ranged from 0 to 10 h with the mean at 3.012 h. The number(s) of social media used ranged from 1 to 10 with the mean at 5.826.

The Academic Achievement on academic record from 70.6 to 90.1 with a mean record of 83.101, and conduct grade from 72.8 to 100 with a mean grade of 84.595 (see the details in Tables 1 and 2).

Table 1. Descriptive statistics-continuous variable

	N	*Min*	*Max*	*M*	*SD*	Skewness
Age	298	15	31	20.22	1.60	1.89
SMTU	298	0	10.0	3.01	1.88	1.07
SMN	298	0	10.0	5.82	1.44	.28
Academic	298	70.6	90.1	83.10	3.50	−.39
Conduct	298	72.8	100	84.60	4.02	.85

Table 2. Descriptive statistics-category variable

			N	%
1.	Grade	1	141	47.3
		2	157	52.7
2.	Gender	Male	207	69.5
		Female	91	30.5
3.	Degrees	High school	144	48.3
		Vocational high school	21	7.0
		College	127	42.6
		University	6	2.0
4.	Loc	External	195	65.4
		Internal	103	34.6

4.2 Chi-Square

Internal and external LOC personality traits, there is a significant difference in the use time of social media. The SHORT group means the time of using social media per day lower than 3.012, and the LONG group means higher than that number (Table 3).

Table 3. 「LOC × SMUT」 Crosstabulation.

LOC\SMUT		SHORT	LONG
Internal	*n*	63	40
	%	40.4	28.2
External	*n*	93	102
	%	59.6	71.8

$\chi^2(1, N = 298) = 4.904$ $p = .027$

4.3 Anova

The effect of social media usage time on conduct grade was analyzed by one-way independent sample variance. The results are shown in the table. It was found that the time spent on using social media was significantly different in terms of conduct grade, $F(1,296) = 6.208$, $p = .013$, $\eta p^2 = .021$ (Table 4).

Table 4. Social media use time and conduct's one-way Anova

Source	*SS*	*df*	*MS*	*F*	*p*	Hp^2
SMUT	98.62	1	98.62	6.208	.013	.021
Error	4702.129	296	15.886			
Total	4800.749	297				

4.4 Mediation Analysis

According to Preacher & Hayes [14], using the multiple mediation procedure for SPSS to check if the conduct grade were directly affected by LOC, or if this connection was mediated by the use time of social media. Each dependent variable was checked for its mediated influences; we calculated standardized coefficients for this. We could see that Internal-External LOC was a significant predictor of the use time of social media ß = 2.70; t(296) = 14.65; $p < 0.001$, and that performance was a significant predictor of conduct grade after controlling for the mediator "the use time of social media": ß = .47; t(296) = 2.06; p = .40. This result reflects a full mediation of approximately 39% of the variance in the variable "conduct grade" was accounted for the predictors (R2 = 0.386). We tested the indirect effect by using a bootstrap estimation approach with 5,000 samples [15]. The indirect coefficient was significant: ß = .37; 99% CI [0.72,4.51].

5 Discussion and Conclusion

We found the relationship between external personality traits and the time spend on social media is positive and significant correlated. Besides, those who have external control personality traits tended to use social media for a longer time and have performed better in the conduct grade.

We analyzed the reasons why those students got better conduct grades than the other. Internal LOC students might be less likely to conform to social influences, and external LOC students, on the opposite, might be more likely to conform to social influences. Students in our study were in a semi-military educational environment in police college, external LOC students may get better performance because of quickly conform to that environment. External LOC students participate in more school activities or responsible for tasks. They might get extra points from complying with the school's code of conduct and norms. Can get higher conduct grade in the end.

The reason why external LOC students use social media for a longer time might be related to their wish to cooperate with peers, teachers, and organizations. Those process needs to be communicated and disseminated through social media. All of these practices will lead to long social media use time.

According to the literature, the use of social media is an important approach to deliver messages and social networks among young students. Compared with the previous literature, it is found that the external control personality traits have a positive and significant impact on the conduct grades. Give us another path to think about the way people use social media and the impact on learning and academic achievement.

Since using social media is essential for a new modern life, following the rise of the social media APP or websites, problems appear too. We should teach students to restrain themselves and use the right way to get better academic results, rather than getting rid of mobile phones and removing social media apps from their mobile phones. It all depends on how you use it. We hope that through more in-depth research, we can find the proper solutions in the future. To avoid students' abuse of social media and improve academic achievement.

6 Limitations and Future Direction

The implementation of this study on police college students should be considered as a limitation. In the future, the validity and reliability of LOC should be examined not only in the college students but also in university students and adolescents in the clinical sample.

It is emphasized that the causes of social media usage are an important factor. For this reason, the relationship between the cause of social media to academic achievement should be examined.

Acknowledgements. The author would like to express gratitude for Taiwan Police College's Intensive School Development Program, for providing financial support and administrative assistance.

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Analysis of Fake News and the Level of Cognitive Perception of Undergraduate Students in the University in Thailand

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Abstract. The purpose of this study aimed to study the relationship between fake news and the cognitive perception of online sources of Thai public. With intensified use in a world of IT devices, more knowledge is available. The Thai trait of belief in all printed or published media must be changed for fake news to be discerned by users. A survey was made by 500 online questionnaires found that much news on social media outlets was a scam, incite feelings against or for a group of people. In Thailand, the general person easily believes in media platform because they are written, and supported by pictures and testimonial information. Fake news was used (1) online items and trusted as things printed are true (2) people express good or bad feelings for a public person, Thai people must for educated form early to doubt.

Keywords: Fake news · Cognitive perception · Undergraduate students · Platform

1 Introduction

Digital user statistics found that the world's most addictive users were Thai people and Bangkok the city with the highest number of Facebook users. In addition, Thai people spend time much each day with the most internet in the world, including all hand-held and office desk devices. [5] The average usage is 9 h 38 min a day. In addition, Thai people spend 3 h playing on social media, an average of 3 h 10 min a day watching TV (Broadcast, Streaming, Video on Demand) and not less than 4 h and 3 min per day for other items. Thailand now has many fake news items on Facebook. There is both partially fake news that twists reality, and newly created entirely fake news for one of several purposes, ranging from money-making scams to either defaming or praising a non-deserving person. From checking fake news and facts on the online world of the Sure Center before sharing, in 2016, the Thai News Agency (MCOT) found that false information in the online world targeted people for health purposes, especially for non-communicable diseases, specifically cancer, because the creators of these false stories know the behavior of device users who lack the skills to monitor digital information throughout the year. In collecting information, it was found there were over 300 fake news stories and that each topic was liked and shared on Facebook together in the main [7]. Lately, not many people trust the information that is forwarded to the social media

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 772–780, 2019.
https://doi.org/10.1007/978-3-030-35343-8_80

world as it is in conflict with academic evidence and medical information. The reason that Thai people trust social media more than doctors results from the content of articles being easier to understand, the ability to get information more often and people being easily duped by people they trust [4].

Cognitive Domain is a cognitive process and the basis for studying the behavior of learning [1]. There are a total of 6 steps, respectively, from low-level knowledge to high-level knowledge. This behavior is an educational purpose in the subject of knowledge, which explains the ability of the brain to collect stories or all the experiences that they have learned. And Facebook fake news exposure level is an important issue that should not be overlooked fake news, either partially made-up or totally unreal, can greatly affect society, causing various problems, such as false rumors of people, lost investments, distorted decisions or beliefs, and finally data or news affecting national security in all aspects. Whether it is economic, political, or other types, the level of intellectual awareness is a factor that has a great influence on online news in this area of Facebook awareness. This research is so beneficial to the public and can be applied to use as a guideline for further recognition of the facts.

2 Review Literature

2.1 Fake News

Fake news, also known as junk news or pseudo-news, is a type of yellow journalism or propaganda that consists of deliberate misinformation or hoaxes spread via traditional news media (print and broadcast) or online social media. The false information is often caused by reporters paying sources for stories, an unethical practice called checkbook journalism. Digital news has brought back and increased the usage of fake news, or yellow journalism. The news is then often reverberated as misinformation in social media but occasionally finds its way to the mainstream media as well [8].

Fake news is created and published usually with the intent to mislead to damage an agency, entity, or person, and/or gain financially or politically, often using sensationalist, dishonest, or outright fabricated headlines to increase readership. Similarly, clickbait stories and headlines earn advertising revenue from this activity.

The relevance of fake news has increased in post-truth politics. For media outlets, the ability to attract viewers to their websites is necessary to generate online advertising revenue. Publishing a story with false content attracts users' benefits, advertisers and improves ratings. Easy access to online advertisement revenue, increased political polarization, and the popularity of social media, primarily the Facebook News Feed, have all been implicated in the spread of fake news, which competes with legitimate news stories. Hostile government actors have also been implicated in generating and propagating fake news, particularly during elections [3].

Confirmation bias and social media algorithms, like those used on Facebook and Twitter, further advance the spread of fake news. Modern impact is felt for example in vaccine hesitancy and also in many false investment plans.

Fake news undermines serious media coverage and makes it more difficult for journalists to cover significant news stories. An analysis by Buzz Feed found that the top 20 fake news stories about the 2016 U.S. presidential election received more engagement on Facebook than the top 20 election stories from 19 major media outlets. Anonymously-hosted fake news websites, who lacked known publishers, have also been criticized because they make it difficult to prosecute sources of fake news for libel.

The term is also at times used to cast doubt upon legitimate news from an opposing political standpoint, a tactic known as the lying press. During and after his presidential campaign and election, Donald Trump popularized the term "fake news" in this sense when he used it to describe the negative press coverage of himself. In part as a result of Trump's use of the term, the term has come under increasing criticism, and in October 2018 the British government decided that it will no longer use the term because it is "a poorly-defined and misleading term that conflates a variety of false information, from genuine error to foreign interference in democratic society.

The International Fact-Checking Network (IFCN), launched in 2015, supports international collaborative efforts in fact-checking, provides training, and has published a code of principles. In 2017 it introduced an application and vetting process for journalistic organizations. One of IFCN's verified signatories, the independent, non-profit media journal The Conversation, created a short animation explaining its fact checking process, which involves "extra checks and balances, including blind peer review by a second academic expert, additional scrutiny and editorial oversight".

2.2 Cognitive Domain

Bloom [1] purposed a distinction between knowledge, comprehension, application, analysis, synthesis, and evaluation.

Knowledge: In the knowledge level of Bloom's Taxonomy, questions are asked solely to test whether a student has gained specific information from the lesson. For example, have they memorized the dates for a particular war or do they know the presidents that served during specific eras in American History. It also includes knowledge of the main ideas that are being taught.

Comprehension: The comprehension level of Bloom's Taxonomy has students go past simply recalling facts and instead has them understanding the information. With this level, they will be able to interpret the facts. Instead of simply being able to name the various types of clouds, for example, the students would be able to understand why each cloud has formed in that manner.

Application: Application questions are those where students have to actually apply, or use, the knowledge they have learned. They might be asked to solve a problem with the information they have gained in class being necessary to create a viable solution. For example, a student might be asked to solve a legal question in an American Government class using the Constitution and its amendments.

Analysis: In the analysis level, students will be required to go beyond knowledge and application and actually see patterns that they can use to analyze a problem. For example, an English teacher might ask what the motives were behind the protagonist's actions during a novel. This requires students to analyze the character and come to a conclusion based on this analysis.

Synthesis: With synthesis, students are required to use the given facts to create new theories or make predictions. They might have to pull in knowledge from multiple subjects and synthesize this information before coming to a conclusion. For example, if a student is asked to invent a new product or game they are being asked to synthesize.

Evaluation: The top level of Bloom's Taxonomy is evaluation. Here students are expected to assess information and come to a conclusion such as its value or the bias behind it. For example, if a student is completing a DBQ (Document Based Question) for an AP US History course, they are expected to evaluate the bias behind any primary or secondary sources in order to see how that affects the points that the speaker is making.

In the end, it is supremely important that we as educators help our students become critical thinkers. Building on knowledge and helping kids begin to apply, analyze, synthesize, and evaluate is the key to helping them grow and prosper in school and beyond.

2.3 Perception

Perception is the ability to capture, process, and actively make sense of the information that our senses receive. It is the cognitive process that makes it possible to interpret our surroundings with the stimuli that we receive throughout sensory organs. This important cognitive ability is essential to our daily lives because it makes it possible to understand our surroundings. It's possible to train and improve perception with cognitive stimulation. Perception is an active process and requires that we process information with both "bottom-up" and "top-down" processing, meaning that we are not only directed by the stimuli that we receive (passive, bottom-up processing) but that we expect and anticipate certain stimuli that control perception (active, top-up processing).

Phases of Perception. Perception is not a single process that happens spontaneously. Instead, it is a series of phases that take place in order for the correct perception of stimuli to occur. For example, to perceive visual information, it's not enough for light to reflect off an object and this stimulating our retinal receptor cells for them to send this information to the correct brain areas. For perception to happen, all of that is necessary. However, perception is an active process, where we have to select, organize and interpret the information sent to the brain.

3 Research Objectives

1. To study the components of the students' perception on Facebook.
2. To study the level of perceived catchy news on Facebook of students.

4 Research Questions

1. Why do Thai undergraduate students believe fake news easily?
2. How can we make Thai undergraduate students discern true or fake news?

5 Research Methodology

This research is a quantitative research to collect catchy news on Facebook and the level of perceived catchy news. The researcher used an online questionnaire to collect data by determining the sample group of 500 students using Facebook who were studying in universities in Bangkok. The questionnaire is divided into 3 parts: Part 1 General information of the respondents, Part 2: Components of the perception of facts on Facebook and Part 3 The level of perceived catchy news on Facebook.

5.1 Components of the Perception of Facts on Facebook

From the analysis found that the level of awareness of Facebook users the overall picture is at the highest level, with the most points being voted on the issue of Facebook in which people are extremely interested in identifying fake news and sources (Table 1).

Table 1. The components of awareness that you perceive as facts.

Issues consideration	Level of opinion					Average
	Much	More	Moderate	Less	The minimum	
Headlines up-to-date, interesting	270	195	34	1	0	3.66
Clearness or content Readers understand the story easily	161	190	110	34	9	4.35
Providing more reliable details	360	111	25	3	1	4.61
News with reference to correct information	172	239	86	3	0	3.96
Clear story of news and make it easy to understand	151	123	128	87	11	3.95
News details- event sequences important and descending	178	195	111	14	2	3.84
Total						4.18

5.2 The Level of Perceived Catchy News on Facebook of Students

From the analysis of the questionnaire, it was found that the sample group had opinions on all issues at the very highest level. The order from lowest to highest as follows: No. 1. Provide reliable details 2. Clearness or content 3. News with reference to correct information 4. There is a clear story of the news and makes it easy to understand.

The order with the lowest mean is still at a high level and the headlines that are up-to-date and interesting (Table 2).

Table 2. The level of perceived catchy news of Facebook.

Issues Consideration	Level of opinion					Average
	Much	More	Moderate	Less	The minimum	
Only read headlines, rough content	25	248	123	82	22	2.85
Only read news interested in and name you like	108	309	74	9	0	4.11
First page enough, no need to read repeatedly	118	299	74	7	2	4.11
Self-read and get the purpose of news	317	153	16	10	4	4.62
From the original news, known Facebook person	25	87	243	94	51	2.85
Content and components created for new story	92	302	86	17	3	3.99
Check news source before deciding facts	356	105	27	8	4	4.62
Considered news comparing news of other sources	192	223	67	11	7	4.35
Self-created news using images, content	324	151	21	1	3	4.54
Images and content news from others	237	68	104	69	22	3.51
Facebook interesting story is true?	301	153	20	22	4	4.65
Doubt to forward news with neutral feeling	156	248	65	23	8	4.36
Total						4.34

6 Discussion

6.1 Characteristics of the Perception on Facebook that Are Perceived as Facts

It can be inferred that the sample group recognizes all issues in question think whether it is true or not because the individual knows that news has reliable details that are consistent with Noosom and Suttisima [6], stated that the most common type of fake news is false news that has been completely created (Bogus) and the most common type of fake news, having all newly invented content, including headlines and material or facts mentioned. Moreover, all the information that appears in the news that was also created and is fake news. The growing number of fake news stories or articles in Thailand seems to have a tendency to decline recently. This may be because of the Computer Crime Act. The spoof newsletter is punishable by a maximum of 7 years' imprisonment. However, Thailand still does not have laws for specific news articles that violate truth and scamming, as people who fall for scams are partly responsible. The belief that most Thai people fall for scams results from the rote-style of learning that published or printed things is true and factual and the school system of education needs to be reevaluated and the skill of discernibility of doubtful things that appear too good to be true in the media of all kinds, including newspapers and TV as well as the internet needs to be taught. In Europe and America, people are skeptical of "great promise" offers on online or internet social media. Thai people need to be educated about these 'scammers', or people who look for victims, and teach them not to let greed control their urge to follow or believe what is on line or printed and accepting that that is true. Presently, here is an online case that explains how a person can turn $250 in an investment today into $1 million in a months' time, without doing any work. Even though it defies common logic, people fall for this due to a greed factor. And the use of a logic model to organize evaluation which the situation was improved for the formative and summative nature of evaluation [9].

In another story, a known infamous person is praised to be a victim when in fact he is an agitator of the honest people in government. Still another shows a respected individual being maligned for things he had no involvement with. These kinds of problems can be reduced or eliminated with better education and the recognition of false information so by the general public, thus cutting down on successful scams and false beliefs caused by false news.

6.2 The Level of Perceived Catchy News on Facebook of Students

From the analysis, it was found that the level of awareness of Facebook users is included in the highest level, with the most average points, is to know that the news on Facebook as there are people who are very interested in finding and learning the truth.

If analyzing the level of perception based on Bloom's Taxonomy model, in this research, the researcher still retains the original concept of Bloom. By considering knowledge or Cognitive Domain (6 levels) as below:

When considering each level, it was found that the level of perceived fraud of Facebook, including 6 levels, was at a high level. And when considering each aspect according to each one, it was found as follows:

Knowledge. The level of awareness in knowledge, reading only the headlines and the rough content of the sample group is moderate with people reading only the news that is interesting and liked at a high level.

Understanding. The level of perception of understanding (Comprehension) of the content that is read on the first page without having to reread at a high level and understand the purpose of the news presentation from reading by one's self was at the highest level.

Applying Knowledge. The level of awareness in applying knowledge (Application) of the news in Facebook has been modified from the walking medium at a moderate level and created content and components to make news on the new level at a high level.

Analysis. This result showed that those who check the source of news before making the decision to know the facts at the highest level and consider news by comparing news from other sources, was always at a high level.

Synthesis. Synthesis: Awareness of the creation of news by using images and content was at the highest level and creation of images and content from others was also at a high level.

Evaluation. The thinking that the news on Facebook that is very interesting to people is true at the highest level and causes people to consider to send forward or not the news from a questionable source or feeling at a high level. The level of perceived catchy news of Facebook. The average sample group is at a high level as is the Valuation level. The lowest level was the level of awareness in knowledge and the level of awareness in applying knowledge to apply research results pointing out that the sample group decided to appraise or summarize the value of things according to their knowledge, understanding, application, analysis, synthesis, or it was possible that most people comment or accept on the issues at hand. That showed that the sample had the highest level of perception was at the perceived level. The researcher noted that if the sample group is aware of such a high level of catchy news, it may adversely affect the overall picture of security in various areas, which depend on the social, economic or political level in society.

7 Conclusions

1. The Thai education system is based on the rote-style learning system for long time which the learners believe in written or published things without question. All taught information is asked to be recalled in testing times, rather than using referential or inferential systems of thinking. When Thais see things on IT devices, most believe all they see as true.
2. Thai students have to be taught by the western style of learning where the students learn to question things and not just accept as true without finding out truth by themselves, using systems like the scientific method and examination processes in order to determine possible reasons for activities or stories.

8 Suggestions

1. There should be a study of the nature of fake news in other popular social media that have the same or different parts of Facebook or not.
2. There should be a study of the level of perceived illusory news that affects the knowledge of the affiliation (Affective domain) and skills (Psychomotor domain) that reflect individuals studied.

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Technologies Enhanced Language Learning

Scenario-Based Learning Exemplification with a Dynamic Video Retrieving Tool for the Second Language Teaching

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Abstract. In most second language teaching environments, the traditional teaching instruction tends to focus on language elements, grammatical rules, and vocabulary memorizing rather than learning on the language in meaningful discourse for successful communication. A simple memory of abstract language elements in a context-free learning environment will make language learning a very difficult task and often frustrate teachers in providing examples of relevant contexts with phrases and sentences. This study describes an interactive video retrieval tool that helps English teachers provide the authentic material of a particular language element which can be viewed in different environments. The tool allows students to access 110 video clips containing examples of contextualized language elements to help them build their perception of the target language. Besides, the tool analyzes the emotional polarity of each subtitle. The result shows that 5814/6000 words could be found by using the tool for Chinese CET-6 training, and the repetition rate the examples was 85% (CET-4) and 87% (CET-6). In a short time, the tool is designed to give teachers access to many dynamic examples from a multimedia corpus, and the choice of teachers can be easily used as a teaching resource for students. The design of this study not only reveals the importance of using dynamic instances in the classroom, but also provides an effective strategy for English teachers to present and explain new vocabulary to students.

Keywords: Language teaching contexts · Dynamic exemplification · Video retrieval · Emotional intent · Sentiment polarity

1 Introduction

1.1 Background in Second Language Acquisition

Learning a second language includes learning its sound system (phonology), word-formation system (morphology), vocabulary (lexicology), grammar system (syntax) and meaning system [1]. However, an overly zealous application of such an analytical approach to the teaching of a second language makes language learning unduly complicated and arduous. Language should focus on communicating perceptions of the universe and of reality itself [2], and for that reason, language lessons must give

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 783–793, 2019.
https://doi.org/10.1007/978-3-030-35343-8_81

attention to the roles played by sound, gesture, and the context in the process of genuine communication [3, 4]. Grammar is the outcome of language development rather than the source where it originates, and learners need extensive opportunities to experience the language personally in order to develop a solid grasp of it and the implied grammar structures [1].

Based on the implicit idea that words are the fundamental linguistic elements, the Ministry of Education of China has prescribed 600–700 words as the basic vocabulary requirement for every elementary and junior high school student, and 3000 words for senior high students. CET-4 and CET-6 are the main indicators of College English proficiency, CET-4 require about 4000 vocabularies, and CET-6 requires about 6000 vocabularies. Although the importance of vocabulary knowledge is widely documented [5, 6], the results of the learning outcome have been far from being satisfactory. As Stewart notes, many second language learners still encounter significant problems with poor comprehension, limited vocabulary, slow reading speed, poor grammar competence, and low conversational skills [7]. Despite the vast array of books available in China that teaches vocabulary and the strategies of learning it, the students often still feel frustrated remembering them, not to mention making use of them inappropriate contexts.

First of all, it is important for teachers to understand how creating mental linkages and using the imagery in order to use more effective methods and tools to teach vocabulary. With a cue association between words and their meaning or their sound, teachers can help promote deeper, more durable learning. Second, Krashen's Affective Filter Hypothesis [8] plays a critical role in second language acquisition and foreign language teaching [9, 10]. Depending on the hypothesis, the role of the learner's affective factors in foreign language learning differs from person to person. Emotional factors of learning can hinder or accelerate the acquisition of language in only in the best emotional conditions will authentic learning be produced. Lu et al. [11] conducted questionnaires and interviews with 1910 students in 21 middle schools in the east, middle, and west of the country. The results showed that 95.1% of the students believed that it is necessary for teachers to improve the teaching effect through the use of the emotional expression, but the teacher is using it only 31.27% [12]. The study presents that the learning is to be stimulated with learner's motivation, emotion, will and psychological factor. Xu and Chen proposed the use of emotional words as materials [13]. The results show that positive words are easier to notice than neutral words and negative words, and react to negative words faster than neutral words and positive words. Therefore, the study shows that emotional information is more likely to be noticed.

The "learning emotional intention" is to be a key factor affecting the students' learning outcomes. English materials are unevenly distributed and poorly targeted in video resources. Especially in the current situation of the rapid development of data and information technology, reducing the time cost of learning is equivalent to greatly improving the efficiency of learning and the amount of knowledge is mastered. The English learning corpus classifies and summarizes the resources of movies and speeches, plays them according to the video subtitle position, and quickly finds the English scene segments that the user needs by searching. At the meanwhile, it has a refereed emotional polarity, so it can grasp the language emotion while learning lots of sentences.

1.2 Dynamic Video Retrieving and Sentiment Analysis

This study first proposes a video retrieval approach to find those scripts containing the keywords entered by the user, and then some of the vocabularies and phrasal verbs, such as “take-off” and “put on”, are chosen as initial queries and used in a Web-based video retrieving tool to search for the related scripts and films which contain the particular queries. Next, the results will be analyzed to pinpoint the desired collocation of words and phrases with sentiment polarity in the segments identified. Sentiment analysis is the most common text classification tool that analyzes an incoming message and tells whether the underlying sentiment is positive, negative, or neutral. The study can select a sentence of your choice and gauge the underlying sentiment by playing with the video. When presenting vocabulary and collocations are presented to the students, referred emotional context provides opportunities for deeper understanding, which facilitates the development of vocabulary and its collocation. Meanwhile, viewing segments whenever they wanted to give the instances will provide the students ample opportunity to experience “real life” English in an exemplifying context.

Depending on Wu [1], meanings are what sounds, words, or gestures refer to and are context-dependent. In order to help students to fully understand the meaning of words and how they are used, teachers must provide different types of contextually embedded linguistic experience, such as reading printed based material or watching film, TV or theater production. These media experience are, to varying degrees, realistic approximations of genuine life experience, and are extensively used to enhance understanding. However, from a teacher’s perspective, teaching vocabulary and providing examples of use to help students build up a flexible, working vocabulary is always a difficult task. In this study, the designed tool is able to find out a wide variety of film-based scenarios by a set of topic-related scripts. With the help of keyword-based queries, teachers are given a multiplicity of film segments tailored to their teaching needs.

2 Method

2.1 Dynamic Example-Learning Mechanism

With regards to language learning, this study speculates that the video clips of TED Talks and Cartoons available on the Internet and provide students with the most culturally relevant, up to date, and accessible examples of the language use. Recognizing the technological and cultural shifts in education, a dynamic “plugged in” language learning device is developed and named Dynamic Video Concordancer (DVC), to support students in the acquisition of new vocabulary and its context. With the DVC, relevant segments of any number of films depicting the multiple examples of target words and phrases can be easily accessed. Rather than memorizing rules students begin to construct their own internalized and intuitive understanding of English vocabulary. The DVC provides a web interface and a multimedia corpus that can search film scripts and play appropriate video clips and its scripts. When the user types a query, e.g. a keyword like “breed”, the tool will show a list of scripts that contain the keyword “breed” and its sentiment polarity. The function, video retrieval module (see

Fig. 1), is to reveal the targeted words with different meanings in different scripts. Thus, a particular word can be presented with examples of usages in various contexts. The tool can help teachers to quickly obtain resource relevant to the teaching of a new vocabulary lesson. Figure 3 presents the exemplifying process that teachers can plan for instruction.

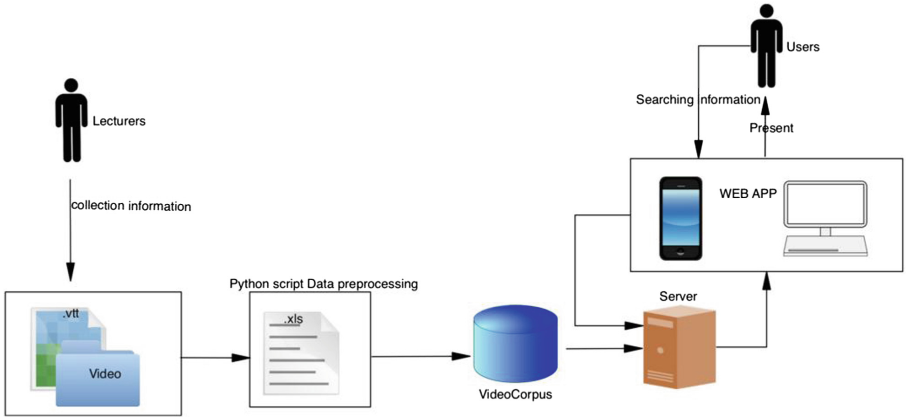

Fig. 1. The learning retrieving mechanism consists of TED Talks video and subtitles with sentiment polarity.

The samples used are from our multimedia corpus of about 100 films, which provides a wide variety of genres and scenarios. There are obviously contextual limitations inherent in using only parts of films. However, we did select the samples based on their applicability to the educational content and the degree to which that content could be exemplified. To further investigate how the use of the DVC can help teachers to meet their teaching goals and enhance vocabulary acquisition, a research approach to English teaching is proposed. This study includes the description of five phases of the research design, as indicated in the chart below (see Fig. 2).

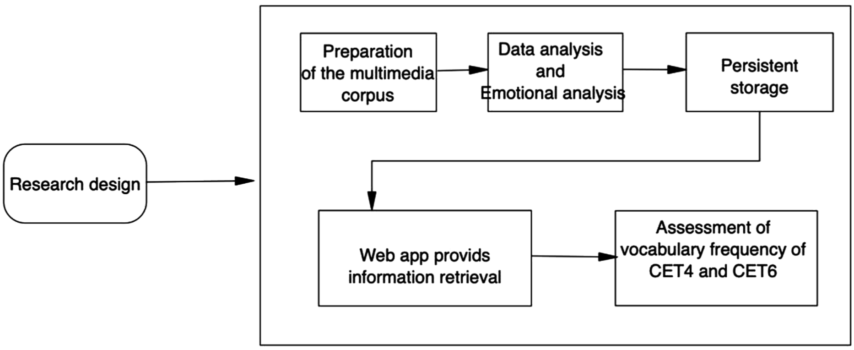

Fig. 2. The flowchart of research design.

2.2 The Repository

The study compiles a collection of 110 TED Talks and Cartoons videos containing scripts with a total of over 20,810 sample sentences. The sample sentences are retrieved from the whole scripts of the videos as resources in this study. Teachers ensure that the videos are uploaded to a video corpus, requiring the raw materials to be pre-processed for network streaming on the Internet. Each film is transformed into the MP4 format Video file format and also contains two formats of scripts: SRT (SubRip) file format and VTT file format. The two formats indicate the timing of each script to allow the video retrieval module to pinpoint the location of any portion of a specified video. In practice, the SubRip format is easily interpreted by the proposed tool, and the VTT format is only supported by the HTML5 Player to the Web interface.

2.3 Sentiment Retrieving

The formula is used to calculate the sentiment polarity of a short text (subtitle) mainly applies natural language analysis and information retrieval technology to quantify the value of the words (see Fig. 3). The first step is the natural language participle, using the Jieba library and making adjustments to parameters and words. The second step is to identify the sentiment polarity of the words, which include positive/negative values mainly rely on the corpus as the snowNLP. However, this way is difficult to identify subjective and objective dictionaries in China. The quality of dictionary resources needs to be readjusted according to professionalism and fine-grained. For example, the word “blue screen” generally does not appear in the sentiment dictionary, but the word clearly expresses dissatisfaction. Therefore, a specific sentiment dictionary is constructed according to the specific field.

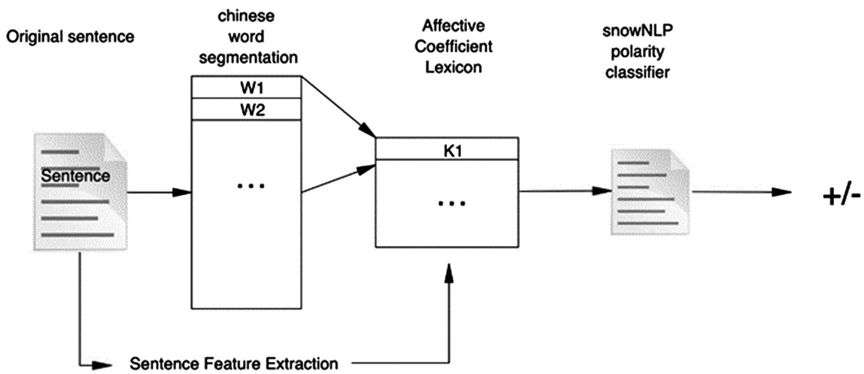

Fig. 3. Subjective use word processing and calculating for sentiment polarity classification.

2.4 Use of the Dynamic Video Concordancer for Vocabulary and Collocations

After teachers upload the scripts and the corresponding videos, a frequency list of the words is created. meanwhile, the DVC also will calculate the sentiment polarity (positive, negative, neutral polarity) of each subtitle according to sentiment corpus as shown in Fig. 4. The frequency list provides teachers with query and teaching references, and many of these words will be compared with the basic word list of CET-4 and CET-6 from Chinese English Test. The resulting matches can be used as a foundation upon which to plan lessons for beginners.

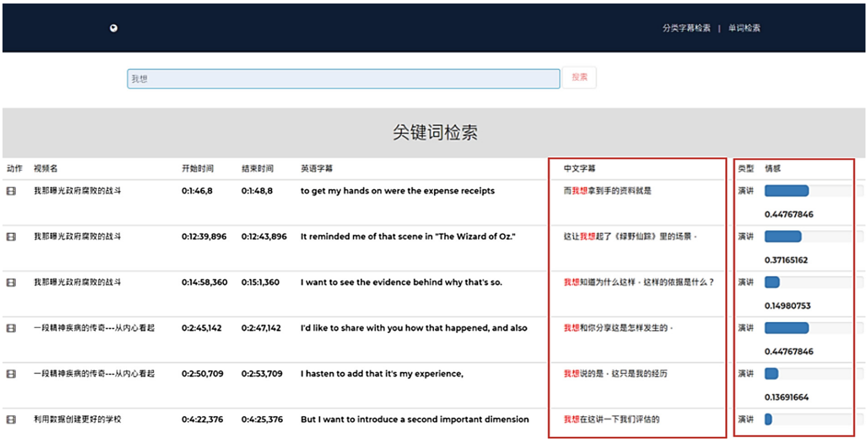

Fig. 4. The layout of the user interface.

*Using the keyword search, the results show that the subtitles in Chinese and English are related to keywords.

**Each subtitle can also express its sentiment polarity.

When a teacher types a query, the DVC accesses a list of films or clips. By clicking on one of the titles, the appropriate segment with its particular script will appear (see Fig. 4). The major components of the Web interface include (a) an HTML5 player (see Fig. 5) which plays each of the film segments by clicking the "Play in English" button. Thus, the Player moves forward to a specific time point for playing video clip, script and its' sentiment polarity, and (b) an inserted frame in which the full scripts of the films can be shown, with the timing that automatically,

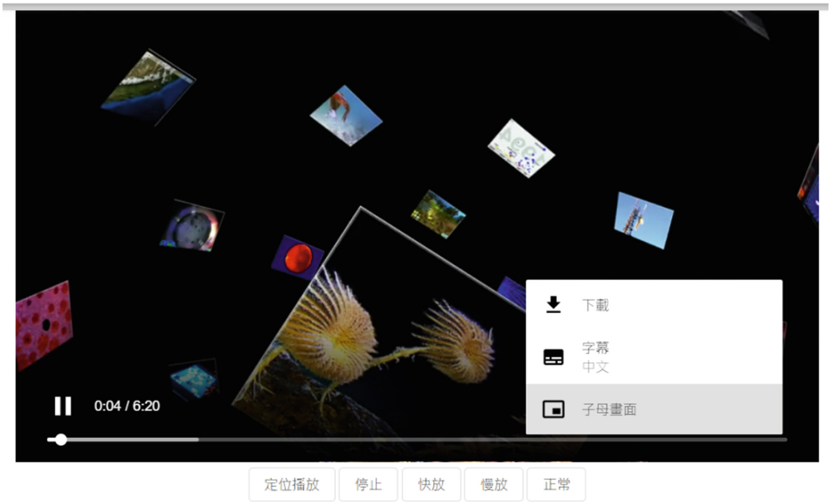

Fig. 5. The HTML5 video player.

*After using keyword querying, the tool can switch to the specified timepoint segment according to the subtitles that have keyword appears.

**An HTML5 Player can dynamically switch between Chinese and English subtitles.

3 Experimental Results and Discussions

3.1 Vocabulary with Dynamic Video Concordancer

The learner enters the keywords they want to search in the search box. Clicking the Search button will display the matching subtitles in the front end. They can also enter phrases or sentences that are able to be searched in English or Chinese. The retrieved information will display the movie name, Chinese and English subtitles matching the user's keywords, start time, end time, movie type, and sentiment polarity of each subtitle. This study further calculates high-frequency words and phrases and gives a classification of CET-4 or CET-6. If you are getting ready for CET-4, you can search for the vocabulary of CET-4 and enhance your learning of CET-4 high-frequency words through conversational scenarios.

The tool allows students to access 100 video clips containing examples of contextualized language elements to help them build their own perception of the target language. In addition, the tool analyzes the sentiment polarity of each subtitle, and lots of studies have shown that learning semantic expression with emotional intent is an essential element. It was shown that using the tool for Chinese CET-6 training, 5814 words could be found (the total number of CET-6 words was 6000), and the repetition rate the examples was 85% (CET-4) and 87% (CET-6) as shown in Table 1. In a short time, the tool can quickly increase the learner's words volume in English.

Table 1. The words list.

	CET-4	CET-6 (Excluding CET-4)	CET-6 (Including CET-4)
Number of words appearing	3882	1076	5814
Number of words not appearing	685	1023	852
Frequency of occurrence	0.8500	0.5131	0.8723
Top 10 by descending order	go(1486), about(517), know(460), use(460), way(393), look(367), end(347), man(340), over(336), see(331)	Chestnut(54), applause(48), govern(27), rally(27), tack(27), architect(23), literal(22), inteact(17), individual(15), generate(14)	go(1486), about(517), know(460), use(460), way(393), look(367), end(347), man(340), over(336), see(331)

3.2 Vocabulary Acquisition with Sentiment Analysis

Take speech video of the TED speech as an example, as shown in Fig. 6. It is called "My battle to expose government corruption", including 17 positive sentences, 102 negative sentences, and 171 neutral sentences. For instance, the subtitle with the context: "120 MPs stepped down at that election" (0.19565, negative), and "so far, four MPs and two lords" (0.44767, neutral) and "have done jail time for fraud." (0.802, positive), being dependent on the context, express negative, natural and positive emotions respectively. Sentiment analysis of Chinese subtitles is based on the snowNLP package, which includes two sentiment lexicons, neg.txt, and pos.txt. The corpus is from e-Comment Corpus and serves as a training model. The sentiment coefficient is 0–1, 0.5 is neutral, less than 0.5 is negative, greater than 0.5 is positive, and then each word is calculated.

3.3 Suggestions for Teachers in Making Use of the Tool in the Classroom

Two articles in CET 4 and CET-6 were used for example analysis. The title of the first article is "The Latest in Cat Research Reveals", The range of words is between CET-4. The article shows that cute animals appear to have been a basic grasp of the laws of physics and the ins and outs of causality. The other is a new study from Duke

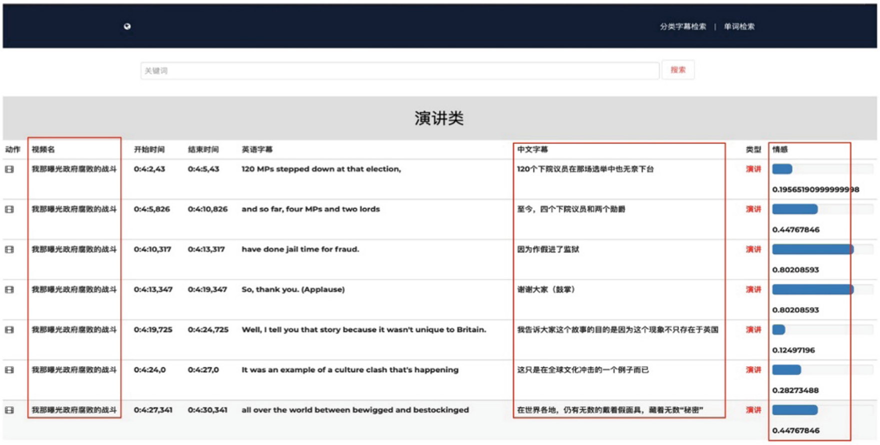

Fig. 6. A layout of video with sentiment polarity.

University, titled "Child Attention in The Early Days of College," which describes a 40% reduction in the likelihood of graduating from high school. The analysis of these two CET-4 and CET-6 articles is mainly aimed at whether the appropriate word examples can be retrieved and provided as an example of language teaching to teachers (Table 2).

Table 2. Response frequency for finding solutions based on the DVC corpus.

	Examples of CET-4 and CET-6		
	Keyword	One of example sentences in corpus	Number of occurrences in corpus
Words exemplification in CET-4	Involve	Loose associations involve putting together words	21
	Professional	They invest in professional development and collaboration	19
	Radical	Is that radical openness? I say it's not, because for me	10
	Domestic	Domestic production activities	2
	Address	It's addressed to "Cleaning good"	9
	Impact	Impacting us the most, perhaps, the most important	8

(*continued*)

Table 2. (*continued*)

	Examples of CET-4 and CET-6		
	Keyword	One of example sentences in corpus	Number of occurrences in corpus
Words exemplification in CET-6	Contribute	Encourage others to contribute whenever they can	2
	Subtle	So, these vocal effects can actually be quite subtle	6
	Negative	Smoking is in some deep sense negative savings	5
	Impact	And we see that in some countries, the impact	8
	Evolution	The scientific revolution wasn't created by the printing press	15
	Privacy	We all worry about our privacy settings	2
	proportion	This is a work of some proportion and some weight	7

In this experiment, the study selected a CET-4 example and a CET-6 example. The keywords listed in the two articles can indeed find two instances in the corpus, and up to 21 examples can be found. Teachers can quickly look for the required instances by searching the corpus. Therefore, it is trustworthy to help teachers to access video-based scenarios for language exemplification.

4 Conclusion

The teaching strategy of focusing on memorizing vocabulary and its definition has been recognized in China as an inefficient way to the acquisition of meaningful vocabulary. Consequently, gaining vocabulary is considered one of the most challenging tasks for students learning a foreign language. Teachers often advise students that doing more practice should help them improve, and thus this paper puts together the language in the course content with video material via the use of an online concordancer.

Although many studies have argued that navigating the sheer volume of visual materials on the Internet is not an efficient way to teach or tutor, fitting examples have been shown in the paper to be useful for language teaching. Moreover, students may increase their interest in learning through the use of vocabulary exercises and video clips which introduce the acquisition of target language and collocation:

1. Students are motivated to learn new vocabulary and its collocations. In the demonstration, instructors were surprised by the ability of the tool to bring such a rich source of materials to the teaching process.

2. The study is different from the existing concordance applications that revealed only linguistic texts. This tool adding the abounded video clips is used to present the context of authentic language and offers a greater variety of videos for students. Therefore, this approach is not only useful for supporting the use of language but also applicable to the understanding of an English spoken setting.
3. The use of the tool is to facilitate the development of teaching strategies that integrate print-based language skills into a social and cultural context. Lecturers can readily identify auxiliary video clips to add, refine and extend new vocabulary related to a topic of study to their lesson plans.

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Using Digital Map Tools to Assist Learning of Argumentative Essay Writing

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Abstract. In this paper, we design and implement a system that uses a digital map system to assist the learning of argumentative essay with Argument map and Concept map. The system had experimented in a primary school with 346 students for 20 weeks that is a whole semester with three groups: Argument Map, Concept Map, and conventional method. The contribution of this study is to improve the quality of student's essay writing by using the advantage of Argument Map. This study compares the effectiveness of the arguments in the essay writing based on the use of different argumentation strategies such as traditional writing, Concept Map writing, and Argumentative Map writing. The experiment results show that Argument Map group is the most significantly improving among the three groups. The analysis results on the improvement on three dimensions of argumentation: (1) claim, reason, and evidence, (2) arguments on supporting the claim and on refuting opposition claim, and (3) completeness and coherence are also reported in the paper.

Keywords: Argument map · Computer-assisted composition · Computer-assisted language learning · Concept map

1 Introduction

Argumentation is the main support for argumentative papers [1]. Argumentation is a method for understanding problems and revealing the importance of them [2]. Argumentation is a key factor affecting the quality of argumentative papers [3]. Persky in 2003 mentioned that students are very difficult to write an essay because they do not have good argumentation ability, which makes the quality in argumentation of the papers poor [4]. Koh in 2004 pointed out the reason for students' poor performance in argumentative writing is that their lack of ability to conduct good arguments; therefore, they cannot integrate relevant evidence, results and opinions into the article. Effective argumentation requires argumentation of support and opposition [2]. Related studies have shown that the ability to argumentation is not available to many people, and they are very difficult to provide evidence to support claims or to argue against them [2].

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 794–801, 2019.
https://doi.org/10.1007/978-3-030-35343-8_82

Studies have shown that graphical organization can help students think effectively and train good argumentative thinking skills [5]. Each graphic organization has different ways of thinking and constructing strategies to present claims [6]. The arguments can illustrate a series of claims-centred support and rebutment of objections [7]. The arguments for support and disapproval are graphs that can be connected together in a tree structure. Moreover, the relationship between these nodes is not a causal relationship, but a defence and rebuttal relationship associated with the claim. Therefore, people can always review whether the reasoning process is logical or assess the comprehensiveness and depth of the problem to be examined. With the rapid development of information technology and the Internet, learners can acquire knowledge or build skills through the Internet, and learning is no longer limited to learning on paper.

With digital technology, people can digitize paper works, such as taking notes and drawing knowledge maps. Compared to paper maps, digital versions such as concept maps and argument maps are more easily modified and stored by learners [8]. Learners can also access their digital knowledge maps whenever they have digital devices. In addition, knowledge maps often have various colours and graphic shapes to express different backgrounds and meanings. These colour and graphics selections have become the internal key function of the digital knowledge map, making it easier for learners to locate interesting parts in knowledge maps.

We hope to help students improve the quality of essay writing. The advantage of the Argument Map is that it provides an argument structure (arguments, reasons, and evidence). We use this advantage to design a "Computer-Aided Argumentative essay writing system". We use a clear box of arguments (arguments, justifications, and evidence) as shown in Fig. 1, which is a tool that helps students organize arguments. The main purpose of this study is to improve the ability of the sixth-grade primary school students to argue in essay writing by using Argument Map. We will compare the effectiveness of the arguments in the essay writing by students who use different argumentation strategies (traditional writing strategies, Concept Map writing strategies, and Argumentative Map writing strategies).

2 Elements of Argumentative Essay

Arguments must consider different perspectives or reasons, and students need to think deeply about providing critical thinking or arguments [9]. Argumentation is the main framework of argumentative essay, and the arguments of the argumentative essay include argument claim, reasons, and evidence [1]. Some scholars use Toulmin's (2003) argumentation strategy to present arguments for the evaluation of argumentation papers, including arguments, reasons, and evidence, and support argument claim and arguments against argument claim, reasons, and evidence [9, 10]. Supporting argumentation and refuting arguments have the same elements - arguments, reasons, and evidence. A lot of related researches are on cultivating students' ability to demonstrate the quality of paper writing [11, 12].

The Argument Map is a tool for argumentation thinking. The structure of the argumentation is pyramid-shaped, and its structure contains support argument claim and refutes opposition argument claim with components of argument claim, reasons,

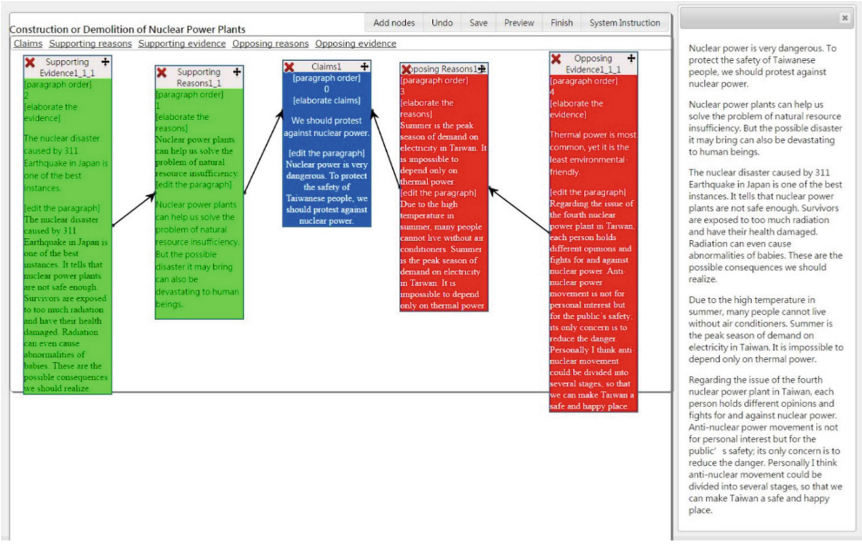

Fig. 1. The system interface of argument map writing assisting system.

and evidence [13]. The argument map can direct all arguments for support and disobedience to the arguments in the coloured text box linked by the arrow so that the relationship between the argument and the argument can be achieved. Some studies have shown that Argument Map can help students learn and improve their thinking skills [14].

3 System Design and Implementation

The purpose of this study is to improve students' ability to write better quality argumentative essays and investigate how the Argument map and Concept map in influencing the learning effects on essay writing. This study designs a digital Argument Map and Concept Map essay writing assisting system and cooperates with the teacher's teaching strategy to help students think stepwise and organize argumentation for the topic. Thus, they can improve the quality of essay writing. The system has two main functions:

- Assist students in establishing arguments:

The digitalized Argument Map and Concept Map can help students think that they will not deviate from the theme. This study uses the three basic elements of the argumentative essay: argument claim, reasons and evidence, as a framework with a digital map representation. In order to allow students to think stepwise about argumentation, the construction of graphics is designed to be gradually built, starting from the creating of argument claim, finding out the supporting reasons, the supporting evidence of the reasoning. They need to establish both supporting and refuting opposition argumentation. Students can also use the stored button to save the latest map and to view and modify the previous maps.

- Assist students in completing writing:

In order to help students to construct their argumentation and then go on to essay writing. The system provides two functions: “paragraph description” and “paragraph organization”. The former focuses on “arguments, reasons, and evidence”; the user can here compile the originally written arguments, reasons, and evidence into complete sentences or paragraphs, including a full description of the grounds for refusing the objection and the evidence against the objection. The latter is to help students turn the construction of the argument structure into the argumentative essay. The order of the paragraphs basically follows the order in which the arguments are constructed, but the students are free to edit their order. Finally, the “Preview” feature in the system will allow students to check the integrity and fluency of their articles. At the same time, they can watch the arguments on map and arguments in essay text to cross-check the consistency of the arguments. The argumentative essay and the corresponding argument map also show that it can help other viewers understand the author’s thinking framework so that the thinking can be seen.

4 Experiment Design

The participants were all students from the sixth grade of a primary school in New Taipei City. There are 11 classes with a total of 269 students. They were assigned to the following three groups: (1) Argument map Group (using Argument map to assist the paper writing system) with 113 students, (2) without map group (using Conventional teaching method) with 75 people. (3) Concept map group (using digital Concept map system to assist writing) with 81 people.

The experimental time of this study is one semester 20 weeks. The experiment includes the teaching of argumentative essay writing, the teaching on different strategies on essay writing, the practice on essay writing, the pre-test and post-test, and the interview with the teacher. Because students were randomly assigned to different experimental groups, this study used ANCOVA for statistical analysis on the pre-test and post-test scores to investigate the difference among learning argument essay writing with different thinking scaffolding tools.

The writing titles of the experiment was decided after discussing by the teacher who participated in the experiment. The titles are designed for the sixth-grade primary school students. The three groups of students used the same titles for learning and training. First, the pre-test was conducted with the same title for three groups. The teacher then explained to the students what the three constructs of an argument essay: claim, reasoning, and supporting evidence. Second, the researchers conducted training on how to write an essay by using digital scaffolding systems with argument map and concept map respectively. Then, the students will learn and practice essay writing by using different methods.

After the learning phase, the students all do a post-test with the same title without any scaffolding tool. The scores of the students’ articles were evaluated by the teachers.

The arguments of the argumentative paper include arguments, reasons and evidence. Many scholars use Toulmin's (2003) argumentation strategy to present arguments for evaluating argumentative papers, including arguments, reasons, and evidence, and supporting arguments and dissuading arguments [10]. The evaluation form is shown in (Table 1). The completeness score of an essay is evaluated by whether the essay has text in the whole three parts in (Table 1), that is, get level score 2 or 3. The coherence score is evaluated by whether each part of the elements consists of its upper element in (Table 1), that is, get level score 3.

Table 1. Average score of Argument Map group, Concept Map group and conventional writing group on support argumentation and refusal opposition argument.

Group	Pre-test *Mean*		Post-test *Mean*	
	Supporting argumentation	Defence of opposing argumentation	Supporting argumentation	Defence of opposing argumentation
Argument map	2.11	1.14	2.81	1.78
Concept map	2.15	1.11	2.80	1.47
Traditional writing	0.82	1.05	2.73	1.90

5 Experiment Results

The main purpose of this study is to validate whether digital thinking maps (Concept map and Argument map) can improve argumentative writing performance of students. At the same time. Comparing how is the effect between Concept map and Argument Map. The study also would like to validate whether the effect of Argument map outperforms Concept map in scaffolding student learning on argumentative writing.

According to ANCOVA analysis, the performance of the three groups in the essay writing is significantly different ($p = 0.002$), and the Argument Map group *(avg.* = 86.4) is better than the Concept Map group (*avg.* = 76.5). Both groups using digital map mechanism outperform the conventional group (*avg.* = 77.2).

The argumentation capability is the key competence of argumentative writing. We thus investigate how students perform in elements of argumentation by using three different approaches. The evaluation includes (1) argumentation elements: argument claim, reasons and evidence, (2) supporting argument claim and refuting opposition arguments claim and, (3) the completeness and consistency of the argumentation. About argument claim s, reasons, and evidence, students can earn 1 point by writing an element. From the analysis of ANCOVA, the three groups were not significant ($p > 0.05$) in the arguments, reasons and evidence, arguments ($p = 0.277$), reasons ($p = 0.724$) and evidence ($p = 0.590$), arguments The average of the group is higher than the average of the arguments and reasons (*argument* = 1.00 and *reason* = 0.99), but as shown in (Fig. 2), the performance of the three groups does not show differences, therefore, we support from Argumentation and "Refutation of Argumentation" analyze the reasons.

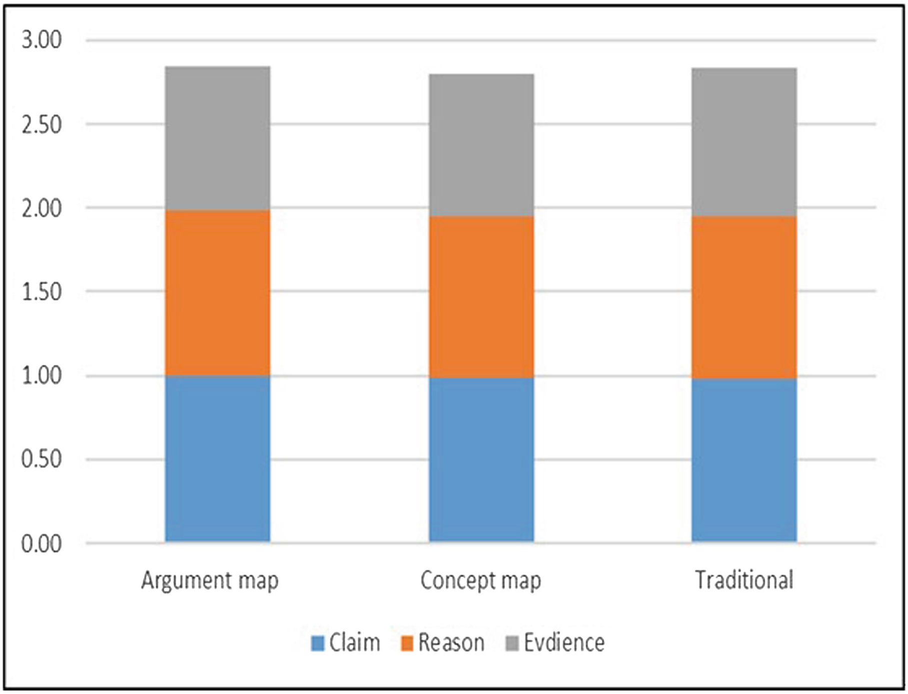

Fig. 2. Scores the Argument map group, the Concept map group, and the conventional writing group: the arguments, reasons, and evidence of the arguments.

According to ANCOVA analysis, groups did not have a significant difference in supporting arguments (0.605). On the other hand, the score difference among three groups of refuting opposition arguments is significant ($p = 0.001$). The score of argument on supporting the claim (2.81) of Argument Map group is higher than the other two groups. Surprisingly, the average score of refuting opposition arguments in the general writing group is the highest at 1.9. The Argument Map group has a significantly higher than Concept group. The results are shown in Table 1.

We then investigate the score difference on the completeness and consistency of the arguments of groups. The result is shown in Table 1. The completeness score among groups have a significant difference from the ANCOVA test ($F = 4.357$), that is, the post-test score is strongly influenced by the experimental operation applied to the student. The score of the general writing group is the best. The Argument Map group is significantly higher than the Concept group. There was a significant difference in the performance of the argument between the Argument Map group and the Concept map group ($p = 0.21$). There was a significant difference between the general writing group and the concept map group ($p = 0.06$).

The coherence assessment is shown in Table 2. The ANCOVA results showed that the independent variable (teaching method) significantly affected the dependent variable ($F = 4.617$). In addition, the post-test score is strongly influenced by the experimental operation applied to the student. Because the ANCOVA result (0.011) reached statistical significance. After the event, it was found that the Argument Map group had significant differences with the concept map group ($p = 0.005$) and the general writing group ($p = 0.35$). The score of the Argument Map group is higher than the other groups. The Concept Map group has the lowest average value.

Table 2. Average scores on completeness and coherence of the essay.

Group	Completeness		Cohesion	
	Pre-test *Mean*	Post-test *Mean*	Pre-test *Mean*	Post-test *Mean*
Argument map	2.34	3.59	2.19	3.50
Concept map	2.35	3.28	2.11	3.11
Traditional writing	2.00	3.65	1.69	3.12

6 Conclusion

Argument writing is to let the author put forward ideas and use persuasive arguments to convince the reader to support the author's position, and effective arguments need to have support and opposition [15]. The purpose of this study is to improve students' thinking and argumentation skills so that they can produce better argumentative essays. We build a learning assist system for argumentative essay writing by scaffolding with digital Argument map and Concept map. The students will devise their argument and description on the map then the system will help the students to transfer from map to a text essay. The system has been used and does the experiment in a primary school for one semester with 20 weeks.

The experiment result shows the students with Argument map learning assistant has a significant improvement than those use Concept map and conventional method in improving their ability on argumentative essay writing. An analysis on the impact on argumentative essay on (1) claims, reason, and evidence, (2) arguments on supporting the claim and on refuting opposition claim, and (3) completeness and coherence. The result shows that there is no significant difference in the argument on the dimension of claim, reason, and evidence among three approaches. There is a significant difference in the dimension of arguments on refuting opposition claim. Surprisingly, the conventional group get the highest score significantly. On the coherence dimension, the Argument Map group significantly outperform other two groups. On the completeness dimension, Argument Map group improve better significantly than that of Concept map. From using digital map to assist essay writing, Argument map is better than Concept map.

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Application of Artificial Intelligence to the Small Open Online English Abstract Writing Course

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Abstract. This project explores the small open online course (SMOOC) and the artificial intelligence (AI) assisted writing, grading and feedback system Quick Research Papers (QRP) that overcomes the traditional teaching method's problems and limitations of class size, space, time, and number of exercises, in order to enhance graduate students' English abstract writing skill. We apply SMOOC and QRP to teach 79 graduate students for abstract writing and track their writing errors in order to pinpoint their writing weaknesses so as to provide better teaching consultation. The results show that only 68 students followed through the second stage of writing the assignment. Total of 12,916 words were written by these 68 students, resulting in total errors of 501; top ten errors are noun, spelling, subject-verb agreement, writing style, common style error, formal writing error, long sentence, incomplete sentence, punctuation, object of verb, respectively. These research findings provide a good clue on how to guide and coach students as a class to enhance their abstract writing skill. Through AI analytics, individual student's weakness can also be identified, leading to more effective individual consultation.

Keywords: Artificial intelligence · Small massive open online course · E-training · English abstract writing · English as a foreign language

1 Introduction

In Taiwan, every graduate student has to write a thesis or dissertation for the final project. Even if the content of the thesis or dissertation is in Chinese, the degree candidate is still required to write the English abstract for his/her thesis or dissertation. However, in Taiwan, English is not the native language; moreover, most graduate students do not major in English or foreign languages. Generally speaking, graduate students of non-English or non-foreign languages have weaker English writing and

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 802–808, 2019.
https://doi.org/10.1007/978-3-030-35343-8_83

wording skills. Consequently, they have to face the problem of writing the English abstract. Thus, employing digital training may be an effective way of equipping graduate students with a good written English abstract writing skill.

Some graduate students have basic English writing skills and comprehension skills when they entered the graduate program whereas some graduate students' English writing skill still needs to be improved [2–4]. Students with weak writing skills require more guidance on how to write English abstracts [4], in order to be able to write good English abstracts.

Distance learning provides convenience for learning. With the popularity of the Internet, novel distance learning methods, such as Massive Open Online Course (MOOC), Small Massive Open Online Course (SMOOC), small private online courses (Small Private Online Course, SPOC), etc., set off a revolutionary approach to education [5]. Among them, the Massive Open Online Course (MOOC) is a topic that attracts many learners to learn resources through the Internet. It is the most popular topic among the public, academic and commercial media. MOOC courses subvert the traditional small classes that are under the constraint of time and space. MOOC is regarded as a destructive innovator of higher education [1, 7, 9]. Since it was first introduced into the teaching medium of distance learning in 2006, it has received a lot of attention [6]. Consequently, a series of large-scale open online courses have emerged. Before moving up in scale to MOOCs, a class design can be developed and tested in the small and medium called Small Massive Open Online Course (SMOOC), as in the current study.

Digital learning efficacy is highly dependent on the management of the digital teaching environments, and there is little research centering on digital training of English abstract writing in Taiwan. To address this research gap, this project explores the massive open online course (MOOC) and the artificial intelligence (AI) assisted grading and feedback system, which will overcome the traditional teaching method's problems and limitations of class size, space, time, and number of exercises, in order to enhance graduate students' English abstract writing skill.

Using AI software to facilitate teaching and decrease teachers' grading workload have gain support over the years. Wang and Liao [10] used Quick English Composition (QEC) cloud software, which is an AI teaching and grading software, to investigate whether the use of QEC could bring any positive impact in critical thinking, English language proficiency, and student satisfaction. Their results indicate that "the students with the assistance of QEC had higher critical thinking ability, as well as English language proficiencies. In addition, they had greater satisfaction toward their English course than those not using the cloud software." Accordingly, this study attempts to use a commercially available research paper artificial intelligence (AI) assisted writing, grading and feedback system, Quick Research Papers (QRP) cloud software, as the tool to AI grade and track the participants' abstracts.

Table 1. Error types

1. Adjective	21. False Plural	41. Passive Voice	61. Split Infinitive
2. Adverb	22. Fiction Style	42. Pejorative	62. Split Words
3. Advertising Style	23. Foreign	43. Possessive Form	63. Subject-Verb Agreement
4. Archaic	24. Formal Writing Error	44. Preposition	64. Subordination
5. Article	25. Formalism	45. Pronoun Case	65. Teacher Custom Error
6. Business Style	26. Gender Specific	46. Pronoun Number Agreement	66. Technical Style
7. Capitalization	27. General Style	47. Proposal Style	67. Tense Shift
8. Cliché	28. Homonym	48. Punctuation	68. Trademark
9. Colloquial	29. Incomplete Sentence	49. Question Mark	69. Unbalanced Parentheses
10. Comma Splice or Fused Sentence	30. Incorrect Verb Form	50. Questionable Usage	70. Vague Adverb
11. Common Style Error	31. Infinitive	51. Quotation Marks	71. Wordy
12. Commonly Confused Word	32. Jargon	52. Redundant	72. Writing Style Error
13. Comparative/ Superlative	33. Journalism Style	53. Relative Pronoun	
14. Conjunction	34. Long Sentence	54. Repeated Word or Punctuation	
15. Documentation Style	35. Mid-Sentence Adverb	55. Report Style	
16. Double Negatives	36. Noun	56. Run-on Sentence	
17. Ellipsis	37. Number Style	57. Sentence Variety	
18. Sentence Preposition	38. Object of Verb	58. Sequence of Tenses	
19. Sentence Punctuation	39. Overstated	59. Similar Words	
20. False Friend	40. Paragraph Problem	60. Spelling	

2 Method

Participants are 79 graduate students, recruited from a central Taiwan university. English abstract writing instruction is delivered through online video lectures and online assignments. Instruction focuses on learning and practicing abstract writing skills. After watching the SMOOC course, graduate students were invited to write their abstract. The researchers employ QRP to check grammatical errors. QRP are set to be able to catch 72 types of errors (Table 1):

Afterward, the researchers also filter the AI detection and provide comments to each individual abstract. The researchers then analyze the students' error type by using built-in assignment statistics of the QRP system to further explore the frequent error types.

3 Results

Out of 79 students participated in the study, only 68 students finished watching the SMOOC course and then wrote the abstract. The other 11 students just watched the SMOOC course without writing the abstract. On the teacher's end, after running the QRP system for catching the 72 errors, on the right-hand side, the system shows the error place (Error) and indicate the error type (Error Type) and provide advice (Reference). On the left side, the strikethrough lines indicate mistakes (Fig. 1).

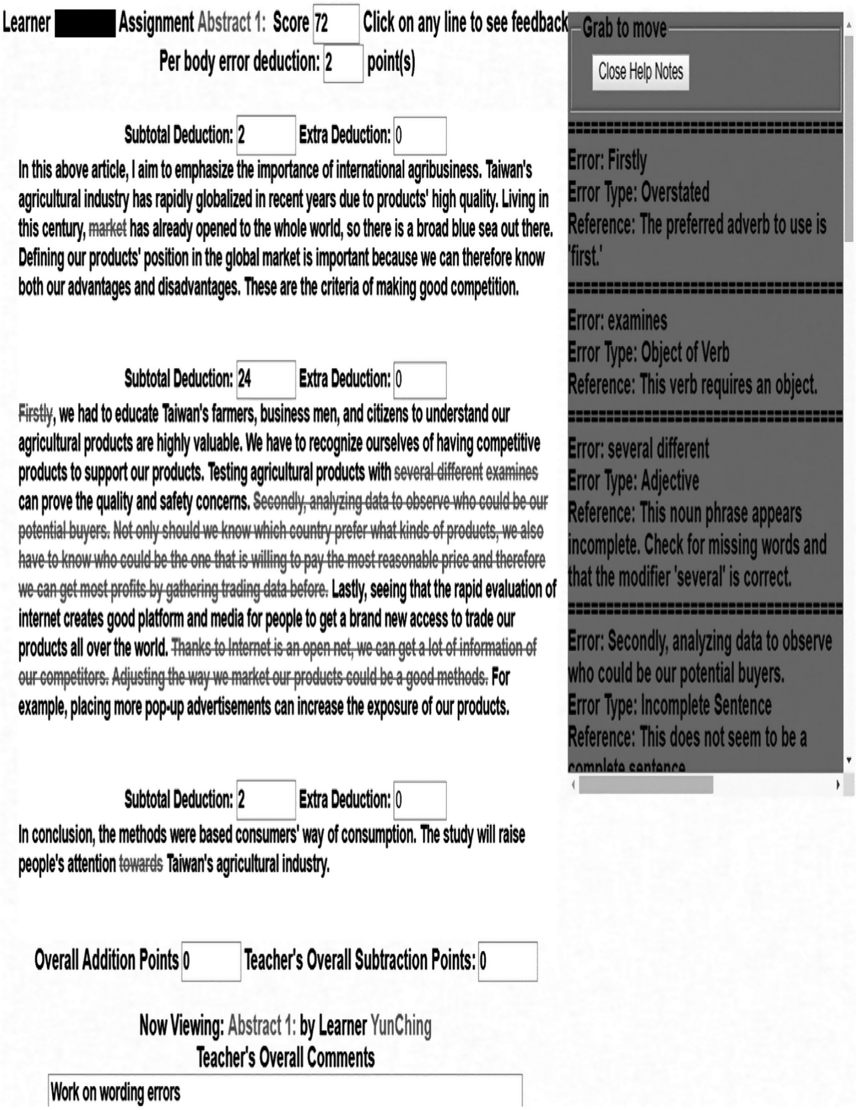

Fig. 1. The teacher filter the AI detection and provide comments to the individual student.

Students can view their mistakes. While the student moves the cursor to the specific "Error" in the yellow box, the yellow color will appear on the red part of the mistake, as shown in Fig. 2.

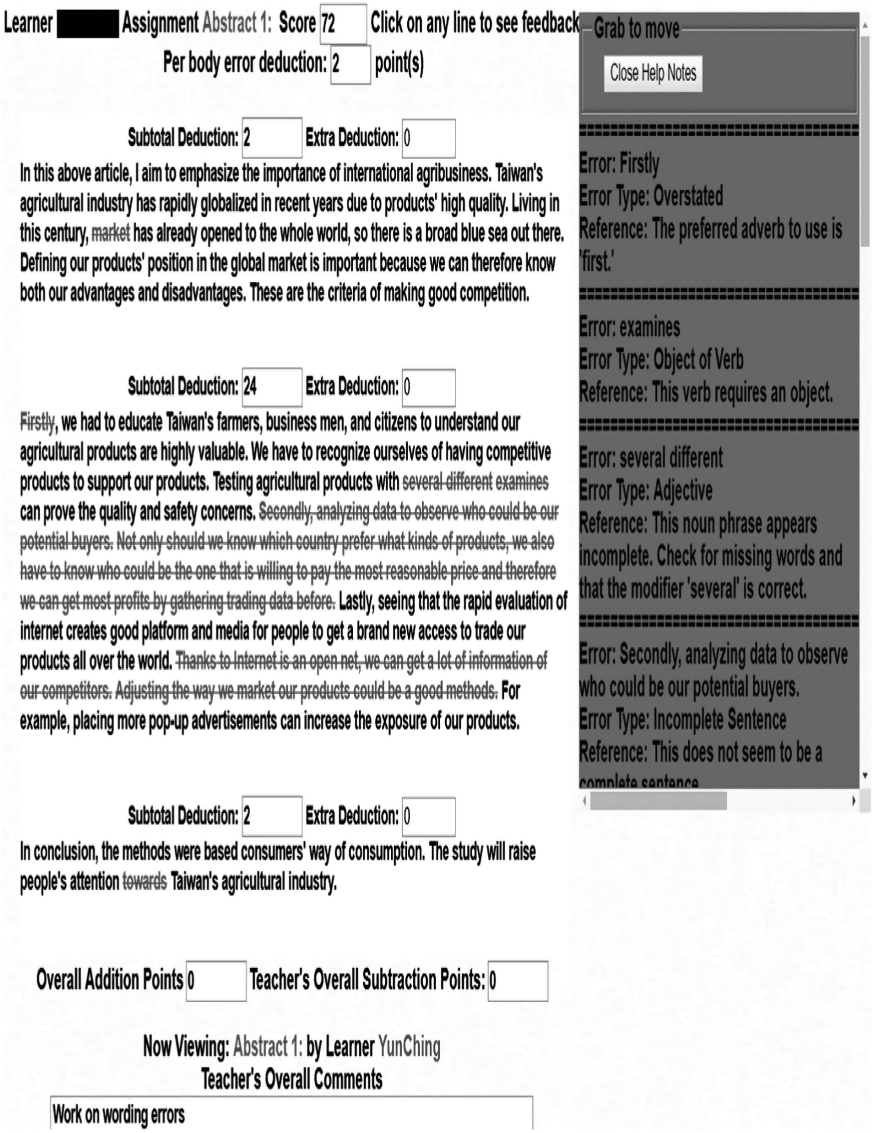

Fig. 2. The student can view the individual error, error type and reference.

The 68 students had written total of 12,916 words, resulting in total errors of 501; top ten errors are noun, spelling (65), subject-verb agreement (50), writing style (33), common style error (33), formal writing error (33), long sentence (22), incomplete sentence (19), punctuation (19), object of verb (16), respectively. Details of the errors are listed in Table 2.

Table 2. Frequency of each error type

Error type	Frequency	Error type	Frequency
Adjective	4	Number Style	1
Adverb	5	Object of Verb	16
Advertising Style	0	Overstated	1
Archaic	0	Paragraph Problem	9
Article	3	Passive Voice	14
Business Style	0	Pejorative	0
Capitalization	3	Possessive Form	9
Cliché	0	Preposition	1
Colloquial	1	Pronoun Case	3
Comma Splice or Fused Sentence	11	Pronoun Number Agreement	5
Common Style Error	33	Proposal Style	0
Commonly Confused Word	1	Punctuation	19
Comparative/Superlative	0	Question Mark	0
Conjunction	0	Questionable Usage	0
Documentation Style	0	Quotation Marks	5
Double Negatives	0	Redundant	0
Ellipsis	0	Relative Pronoun	1
End of Sentence Preposition	1	Repeated Word or Punctuation	2
End of Sentence Punctuation	0	Report Style	0
False Friend	0	Run-on Sentence	0
False Plural	0	Sentence Variety	8
Fiction Style	0	Sequence of Tenses	0
Foreign	0	Similar Words	0
Formal Writing Error	33	Spelling	65
Formalism	3	Split Infinitive	0
Gender Specific	0	Split Words	0
General Style	0	Subject-Verb Agreement	50
Homonym	2	Subordination	1
Incomplete Sentence	19	Teacher Custom Error	0
Incorrect Verb Form	14	Technical Style	0
Infinitive	3	Tense Shift	1
Jargon	0	Trademark	1
Journalism Style	0	Unbalanced Parentheses	3
Long Sentence	22	Vague Adverb	0
Mid-Sentence Adverb	0	Wordy	11
Noun	84	Writing Style Error	33

4 Conclusion

The current research findings provide a specific insight on where to strengthen the emphasis of teaching and educate the students to avoid common writing errors, such as spelling, subject-verb agreement, writing style, common style error, formal writing error, long sentence, incomplete sentence, punctuation, and object of verb. By employing AI into teaching, teachers not only can quickly understand the overall weakness of a class but also can prepare the optimum materials to lecture. Moreover, the teacher can also track each individual student and provide one to one counseling, leading to more effective teaching.

Acknowledgment. The authors are grateful to the Ministry of Science and Technology of the Republic of China, Taiwan, for financially supporting this research under Contract No. MOST 107-2511-H-240-001.

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Impact of Speech-Enabled Language Translation Application on Perceived Learning Emotions in Lectures in English as a Medium of Instruction

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Abstract. In this study, researchers applied speech-enabled language translation (SELT) technology during lectures in English as a medium of instruction in order to improve student perceived learning emotions. Thirty three university students participated in this study. Their perceived learning emotions were measured before, during, and after class using the questionnaire. The difference in perceived learning emotions of all students before, during and after class was compared. In addition, learning emotions of low EFL ability and high EFL ability students were compared. The results showed no significant difference in perceived learning emotions of all students before, during, and after class. There was a significant difference in perceived learning emotions between low EFL ability students and high EFL ability students. Perceived learning emotions of high EFL ability students were significantly better before class but significantly lower during and after class compared to those of low EFL ability students. This result suggests that SELT was beneficial for perceived learning emotions of low EFL ability students during and after lectures in English as a medium of instruction.

Keywords: Speech-enabled language translation · Perceived learning emotions · EFL ability · English as a medium of instruction · Lectures

1 Introduction

Recent evidence suggests that not every student attending lectures in a foreign language as the medium of instruction fully understands the lecture content [1, 2]. Typically, students with low language ability suffer in such situations [3]. That is, low language ability students must exert extra effort to achieve comprehension, and even when extra effort is being made, some of them are still unable to understand what is being communicated to them [4]. It is likely that such issues affect student emotions.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 809–814, 2019.
https://doi.org/10.1007/978-3-030-35343-8_84

Emotions are defined as feelings [5]. According to Reeve [6], "Emotions are short-lived, feeling-arousal-purposive-expressive phenomena that help us adapt to the opportunities and challenges we face during important life events." Stark et al. [7] suggested that emotions are multi-faceted phenomena and can be evoked by certain stimuli such as events or experiences, evolve from individual's appraisals of these stimuli, and involve experiential, physiological, and behavioral activity. Learning emotions refer to emotions related to learning and they can be differentiated by their range from negative to positive [8].

It is likely for some students to have negative emotions when attending lectures in a foreign language as the medium of instruction, especially for those with low language ability, because comprehending lecture content for them is difficult. According to scholars, emotions play an important role in the learning process [9]. Stark et al. [7] suggested that positive emotions can be beneficial to learning whereas negative emotions may impair successful learning. So when students attend lectures in a foreign language as the medium of instruction, they do not try to comprehend lecture content. This phenomenon can be explained by the emotions-as-suppressor-of-learning hypothesis. According to this hypothesis, negative emotions have impairing effect on learning because their cognitive component occupies cognitive capacity and impose extraneous cognitive load [9]. Therefore, educators and researchers need to consider student emotion and how to make it positive when designing their instruction.

Scholars have attempted to facilitate student comprehension of lecture content delivered in a foreign language as the medium of instruction by proposing various technological interventions [10]. For example, Arcon et al. [11] applied speech-to-text recognition (STR) technology to lectures. STR synchronously generated text streams from speech input that were then shown to the participants [12, 13]. According to Mirzaei et al. [14] STR-texts can help participants comprehend learning content better. The reason is because STR-texts are useful to confirm what is being said [12]. However, we argue that the content of academic events still can be difficult to understand for some participants, especially for those with low language ability, because the speaker speaks in a target foreign language, and texts generated by STR are also in the same language (i.e. foreign language). Therefore, we aimed to address this issue in our study. To this end, we applied speech-enabled language translation (SELT) to lectures in a foreign language as the medium of instruction in order to improve student learning emotions [15]. SELT technology received speech input from the instructor, translated it into the native language of the students, and showed the students the translated output [16, 17]. We aimed to explore whether there is a difference in student perceived learning emotions before class, during class, and after class. Furthermore, we investigated the difference in perceived learning emotions of students with low and high EFL ability before class, during class, and after class. To this end, the following research questions were addressed: (1) Is there any difference in student perceived emotions before class, during class, and after class? (2) Is there any difference in perceived emotions of students with low and high EFL ability before class, during class, and after class?

2 Method

Thirty three undergraduate students from one public university in southern Taiwan participated. All participants were native speakers of Mandarin Chinese, and English was their foreign language. They attended two lectures in English as the medium of instruction. The participants received an intervention in form of texts generated by speech-enabled language translation to facilitate their comprehension of the lecture content. Speech-enabled language translation technology receives the instructor's speech input, translates it from English into Mandarin Chinese, and then displays texts on computer screens or white board for the participants during lectures. After lectures, a questionnaire was administered. The questionnaire was designed based on general recommendations of Pekrun et al. [18]. This instrument was applied to many related educational studies, and therefore it is valid and reliable. The participants rated their emotions in class using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The following rubrics were applied to measure perceived learning emotions: (score range from 1 to 1.67) - low level of perception, (score range from 1.68 to 3.33) - medium level of perception, and (score range from 3.34 to 5) - high level of perception.

3 Results

3.1 All Students

Descriptive statistics of perceived emotions by all students before class, during class, and after class are show in Table 1. According to the results, the students perceived high level of positive emotions before class (M = 3.58; SD = 0.79), during class (M = 3.76; SD = 0.37), and after class (M = 3.70; p = 0.41). ANOVA results revealed no significant differences among student perceptions of their emotions before class, during class, and after class, F = 0.925, p = 0.400.

Table 1. Mean and standard deviation values of learning emotions for all students.

Positive emotions	Mean	Standard deviation
Before class	3.58	0.79
During class	3.76	0.37
After class	3.70	0.41

3.2 Low EFL Ability Versus High EFL Ability Students

The students were divided into low EFL ability and high EFL ability groups based on their EFL scores. Descriptive statistics of perceived emotions by low EFL ability and high EFL ability before class, during class, and after class are show in Table 2. According to the results, low EFL ability students had medium level of perceived emotions before class (M = 3.18; SD = 0.83) and high level of perceived emotions during class (M = 3.93; SD = 0.26) and after class (M = 3.87; SD = 0.33). High EFL ability students had high level of perceived emotions before class (M = 3.99; M = 0.48), during class (M = 3.57; SD = 0.38), and after class (M = 3.53; SD = 0.41). The results of independent samples t test revealed that there was a significant difference between low EFL ability and high EFL ability in their perceived emotions before class, during class, and after class. However, the results are very interesting. The thing is that high EFL ability students' level of perceived emotions was significantly higher than that of their counterparts before class, $t = -3.439$; $p = 0.002$. However, level of perceived emotions of low EFL ability students turned to be higher than that of high EFL ability students during class ($t = 3.191$; $p = 0.003$) and after class ($t = 2.601$; $p = 0.014$) (Table 3).

Table 2. ANOVA results of learning emotions for all students.

Positive emotions	*SS*	*df*	*MS*	*F*	*Sig.*
Between groups	0.572	2	0.286	0.925	0.400
Within groups	29.664	96	0.309		
Total	30.235	98			

Table 3. Mean and standard deviation values of learning emotions with respect to low and high EFL ability students.

Positive emotions	Low ability		High ability		*t*	*p*
	M	*SD*	*M*	*SD*		
Before class	3.18	0.83	3.99	0.48	−3.439	0.002
During class	3.93	0.26	3.57	0.38	3.191	0.003
After class	3.87	0.33	3.53	0.41	2.601	0.014

4 Discussion and Conclusion

The results of this study showed that there was no significant difference in student emotions before, during, and after class. The results also showed that there was a significant difference in student emotions between low EFL ability students and high EFL ability students. Emotions of high EFL ability students were significantly better before class but significantly lower during and after class compared to those of low EFL ability students. This result suggests that SELT was beneficial for learning emotions of low EFL ability students during and after lectures in English as a medium of instruction.

It is difficult to comprehend lecture content in a foreign language as the medium of instruction for some students, especially for those with low language ability [1–4]. As a result, student may have negative learning emotions. This notion is supported by the emotions-as-suppressor-of-learning hypothesis [9]. According to this hypothesis, negative emotions have impairing effect on learning because their cognitive component occupies cognitive capacity and impose extraneous cognitive load [7].

In this study, we aimed to address this issue and facilitate student emotions. Before lectures, low EFL ability students had low level of perceived emotions and high EFL ability had high level of perceived emotions. This is because of their EFL level and confidence to comprehend lectures' content. We displayed SELT-texts to the students during lectures so that they can comprehend lectures' content better. As a result, level of perceived emotions of low EFL ability students was significantly higher during and after lectures compared to that of high EFL ability students. After SELT-texts were displayed to low EFL ability students, their comprehension of lecture content was facilitated and emotions improved. On the other hand, high EFL ability students did not use SELT-texts because their EFL ability was high and they were able to comprehend lecture content without any support. In contrast, SELT-texts were distracting for high EFL ability students and caused their emotions' level decrease.

When we compared emotions of all students before, during, and after lectures there was no any difference. This is because we compared emotions of all students together including low and high EFL ability. The difference becomes statistical when we separate students into different ability groups.

Based on our results, we may conclude that SELT-texts were beneficial for low EFL ability students whereas useless for high EFL ability students. Therefore, SELT-texts can be used to support comprehension of lecture content by low EFL ability students. Educators and researchers may use adaptive approach to show SELT-texts to students of different ability either manually or automatically.

In the future, we will explore how SELT-text can be useful for improving test-related emotions. Usually, the instructors assign some tasks or tests for students after lectures to measure their comprehension of lecture content. We assume that, in line with the emotions-as-suppressor-of-learning hypothesis, students may have negative emotions to complete assigned tasks and/or tests which may negatively impact their learning outcomes. We will investigate whether displaying SELT-texts can help students improve their test-related emotions and facilitate learning outcomes.

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The Effects of Virtual Learning Environment on High School Students' English Learning Performance and Attitude

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Abstract. The purpose of this study is to explore the effect of virtual multimedia teaching on high school students' English academic performance and learning attitude. This study especially focuses on using virtual learning environments to assist students to language learning. This study developed a virtual learning environment (VLE) to help foreign language learners learn English. The use of VLE provides learners with the opportunity to develop a sense of community, like a learning community. In this study, 120 freshmen from a high school in Kaohsiung city were studied. The 120 students were divided into two groups. One was Experimental class; the other is Control class. This course is based on the English proficiency of the students. The results show that VLE can help students improve their English learning performance and attitude. Students in this study considered VLE to be a meaningful learning method, which provided them with more opportunities to interact with their classmates in online group work.

Keywords: English as a foreign language · Virtual learning environment · Learning performance · Learning attitude

1 Introduction

1.1 Background and Motivation

English has become the main medium for communication and cross-cultural information exchange with many countries in the world. Therefore, in response to the "challenge 2008" national development plan [1], Taiwan has developed important measures to promote English teaching in order to enhance its global competitiveness. Since 2005, the Ministry of Education has implemented a new policy to start English teaching in the third grade of primary school instead of the original fifth grade. This is one of the most important initiatives of the Ministry of Education.

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 815–824, 2019.
https://doi.org/10.1007/978-3-030-35343-8_85

Recently, a large number of studies have demonstrated the benefits of the Internet or multimedia based tools in many areas of language, science, mathematics and social studies; From preschool education to higher education. In the context of higher education, the impact of computers and the Internet on language learning has grown increasingly. The early advent of the Internet a few years ago gave students the opportunity to search data online and share their findings with other language learners.

The use of the Virtual Learning Environment (VLE) has been gradually promoted to the education system at different stages. VLE emphasizes creating a multimedia learning resource through online and digital technology. With this kind of online and digital learning resources, the constructed learning environment can be applied to the auxiliary online courses in school education, or it can be constructed into a virtual campus learning environment. With the continuous innovation of digital information technology today, this online and digital virtual learning environment is bound to play a more important role for all learners in different education systems.

The breakthrough of VLE is that it changes the way people see the world. In the past, if you wanted to teach students how to understand the mysteries of the universe in the nature course, most of the teachers just explain or show pictures for students to see in class. At most, relevant videos are shown, so that students cannot fully understand the real situation and shape of the operation of the universe with only a partial knowledge. VLE allows students to directly feel the movement of the planets in the middle of the universe through the virtual environment, just like experiencing the scene. If you learn, you will understand the links more clearly.

In a learning environment, providing diverse learning resources and activities, allowing students to have more choices of choice is the basic condition for ensuring that students have a more positive learning attitude and better academic achievement. Therefore, the key to building an ecosystem is to design diverse learning resources and activities to suit the diverse needs of students. It is said that learning is an points out that learning is an ecosystem, a process of continuous change and a lifelong process. Therefore, learning ecosystem should be a collection of learning communities with different needs, a learning environment in which groups and individuals can learn from each other and benefit from each other, continuously evolve and self-organize.

This study hopes to explore the impact of using VLE teaching methods on learning English. The study pointed out that even if the learner is familiar with the use of related technology, it does not mean that he can fully use it in the process of education and learning [2]. Through the tools of the questionnaire survey and the test results after the VLE teaching experiment, it is found that the degree of students' use of VLE will be a key factor. In addition, today's trends in language learning have also found that learners are willing to use some new tools to assist, but this must rely on teachers to lead students to learn to use emerging information technology and give full guidance in the process [3]. At the same time, this study will further explore how teachers can use more effective methods to guide students through VLE to improve their motivation and effectiveness.

1.2 Purposes of the Study

The purpose of this study is to investigate the effect of virtual learning environment on English classroom learning ability. This study takes students' English reading performance and Internet interaction as the key to characterize the VLE effect. Due to the heterogeneity of high school English classroom, this study further explores the influence of virtual learning environment (VLE) on improving students' English proficiency and English learning attitude.

1.3 Research Questions

This study aims to explore the following research questions:

1. In terms of learning attitude, do students prefer the integration of virtual learning environment (VLE) and traditional teaching (TT)?
2. Does VLE assist students to perform better in language than TT?

2 Literature Review

2.1 The Traditional Teaching Approach in EFL

In this section, the discussion is primarily focused on three parts. They include characteristics, strengths and shortcomings of the traditional teaching approach, the virtual learning environment, and language learning in the virtual learning environment.

The Characteristics

The phrase "traditional methods" in the study refers to the grammar translation methods that commanded European and foreign language teaching in the 1940s and 1940s [4]. Richards and Rodgers [4] presented a few main characteristics of grammatical translation methods:

In the beginning, it represents the deductive method, which means that teachers first analyze grammar rules and language projects in detail, and then use this knowledge to translate sentences and contents into the target language. Secondly, reading and writing are the key points; there's almost no systematic attention being paid to listening or speaking. Thirdly, the expression and interpretation of grammatical rules are emphasized. Fourthly, students are required to make sentences in the target language in the process of teaching and language practice. Most course projects translate sentences into or from the target language. Fifthly, accuracy is highly stressed, which is a prerequisite for passing the formal written test. The teacher is the authority that the student gets the right answer. Finally, the mother tongue is the language of instruction. It is applied for explaining new things and compare foreign languages with students' native languages [5].

The Strengths and Shortcomings

Grammar translation and its modification have been extensively used in many nations. Brown [6] explains some of the reasons for its popularity.

Firstly, teachers need less professional skills to implement this method. Second, grammar tests can be set up and scored more easily and objectively. Finally, sometimes it is effective to improve students' reading knowledge. However, some researchers also discussed the problems and shortcomings of this method.

Brown [6] declaimed that grammar translation method is of no use for improving students' communicative competence. For thousands of foreign students, the translation method they have experienced is boring, endless memorizing a long list of useless grammar rules or words, trying to perfect the translation of literary advice. In addition, there is no communicator or relevant literature, such as linguistics, psychology or educational theory, to justify the method and provide a theoretical basis [4].

Many English teachers still use traditional methods or advice, such as those in Taiwan, to help their less professionally skilled teachers because of their advantages, to be prepared to easily construct tests and possible advantages to enhance the abilities of reading and writing. However, this approach is theoretically inadequate and inconsistent with the nature of language use. Therefore, in this study, virtual learning environment (VLE) is considered as a better learning method to help students learn English.

2.2 The Virtual Learning Environment

Virtual learning environment, known as artificial environment, artificial world or virtual environment, literally means "virtual" and "real" is the real environment, so "virtual reality" is a fictional reality created by the computer. The realization of virtual reality enables us to "get to the reality without going out". Basically, the virtual reality system is a new interface that integrates graphics, sound, video, animation and related peripherals to enable communication and interaction between humans and computers. It provides a new 3d visual, auditory and interactive human-machine interface [7].

The earliest development of virtual reality originated in 1962. Because VLE is an applied engineering, it also contains a strong commercial flavor, and it has not been paid attention to by the academic community until recent years. Hamilton [8] initial research goal was set in the direction of medical engineering and educational engineering, until 1993, when IEEE formally organized a seminar on VLE research, and then VLE entered the stage of booming development. Nowadays, virtual reality has been widely used in our general life, no matter in military affairs, medicine, education, entertainment, etc., and the technology of virtual reality has been applied in a large number of cases, changing our view on human-computer interaction.

2.3 Language Learning in the Virtual Learning Environment

Education in the past from the earliest blackboard and dictation, until now there are projectors and electronic whiteboard subsidize teaching, it can be said that the teaching equipment in the field of education is constantly improving. But we will find that a teacher, a blackboard and a classroom scene of dozens or hundreds of students still exist in the modern educational environment, and the teaching method remains unchanged for a hundred years. However, with the rapid development of science and technology and continuous innovation, it also drives the development of education reform. Imagine that wearing a VLE helmet in a VLE classroom is like walking into an art museum to have an art class and actually appreciate van gogh art, which cannot be done in traditional teaching methods and traditional classrooms.

From the perspective of the actual development and application of VLE, what is different from the traditional education in the past is that the plane content can be presented in a physical scene. For example, historical sites can be seen in history class, central mountains or gorges in geography class, and even medical students in the future can simulate surgery through VLE. There are many foreign researches on the application of augmented reality in teaching. Asai, Kobayashi and Kondo [9] also believe that augmented reality is a new type of teaching that can be greatly developed in the future. Baer and Kaufman [10] summarizes six years he augmented reality and virtual reality is applied to research of geometry teaching, the conclusion shows that both students and teachers have considerable interest for learning, analysis and assessment of the three major, altogether collected more than 100 students and 500 teaching unit of research data, the results show that the researchers of the development of the Construct 3 d tool is easy to use, does not need too much time to study, to make students in a few when encouraged, and the simulated situational learning effect with consistency. Therefore, augmented reality is a new teaching mode that can increase students' learning effect and interest. From the perspective of the use of VLE virtual environment in the education field, virtual reality to solve the limitation of the traditional education cannot meet, will bring the textbook face blunt knowledge lifelike, experience life through situation as well as increase the students' enthusiasm for learning, and through repeated practice to learn more knowledge and experience, to learn is not only confined to the classroom and blackboard.

3 Methodology

3.1 Participants

In this study, 120 freshmen from a high school in Kaohsiung city were studied, including 60 male students and 60 female students. The 120 students were divided into two groups: one was an experimental class; the other is the control class. This course is based on the English proficiency of the students.

The English teachers of these two classes are the researchers of this study. The two phases of this study were completed in one semester and two hours of classroom teaching per week.

In the experimental class, the English teacher assigned some homework according to the textbook, and allowed students to conduct online group discussions through Facebook during the semester. In the control class, the English teacher guided the students according to the content of the textbook, without giving them any questions for online group discussion.

3.2 Instruments

The tools used in this study include test paper, questionnaire survey and Windows SPSS as a statistical tool for data analysis.

3.3 Data Collection and Analysis

The data in this study were composed of students' responses to questionnaires and collected from students' final exam scores. In addition, the survey results and test scores were quantitatively analyzed.

4 Results and Discussion

4.1 Impact on Students' Preference of the English Learning Attitude to Facebook and Traditional Teaching

Q1. Do students prefer Virtual Learning Environment (VLE) to traditional teaching (TT) in terms of the learning attitude?

Table 1. Independent samples test analysis summary comparing of the pretest scores of English Proficiency between students in experimental and control group.

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	60	61.043	13.351	−1.024	0.137
Control group	60	63.501	11.029		

$^{*}p < .05$

As can be seen from Table 1, the statistical results of students' English proficiency before treatment showed no significant difference between Experimental group and Control group ($t = -1.024$, $p = .137$). So this indicates that these two groups are homogeneous. In fact, it can be even implied that students may not have a learning attitude towards VLE and TT prior to the implementation of treatment, preferring another learning attitude.

However, in order to understand whether students preferred VLE over TBI after treatment, we analyzed 25 alternative responses to the cooperative learning attitude questionnaire (part ii) from an independent sample. The experimental group was compared with the control group, and the experimental group was tested with paired samples.

Table 2. Independent samples test analysis comparing the English learning attitude of experimental group and control group by the post-treatment questionnaire

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	60	86.310	10.501	3.358	.000
Control group	60	71.537	8.271		

$^{*}p < .05$

From the data analysis in the second part of the questionnaire in Table 2, it can be seen that there is a significant difference in English learning attitude between Experimental group (M = 86.31, SD = 11.61) and Control group (t = 3.358, p = organization). (M = 71.53, SD = 8.27); that is to say, the preference of students in Experimental group to virtual learning environment (VLE) was stronger than that of students in Control group. This was also true when we specifically considered students in Experimental group who had completed treatment (VLE).

Table 3. Analysis of paired-sample test of attitudes of virtual learning environment before and after treatment in experimental group

Group		*M*	*SD*	*t*	*p*
Experimental	Before	85.613	4.235	2.046	.028
	After	90.518	10.307		

$^{*}p < .05$

According to Table 3, the same data were analyzed in the second part of the experiment. According to the questionnaire survey, the attitude or preference of the experimental group towards the virtual learning environment (1) before and after the treatment, as an attitude towards learning English, promoted the SD after treatment at 85.613 and 4.235, with an average of 90.518 and a standard deviation of 10.307 (t = 2.046, p = .028). Therefore, in this study, the attitude or preference towards English learning of students in the experimental group after VLE treatment changed significantly. Participants had a positive attitude toward learning English at VLE, or preferred to learn English through VLE. In fact, this learning attitude does increase their interest and attitude towards English learning, as shown in the answer to question 2 in Sect. 4.2.

4.2 Impacts of the Virtual Learning Environment (VLE) on Students' Learning Performing

Q2. Does VLE motivate students to perform better in their language learning as compared with TT?

Table 4. An analytical summary of independent sample test used to compare students' pretest scores in experimental and control groups before the treatment.

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	60	52.162	3.275	.581	.352
Control group	60	53.529	4.138		

$^{*}p < .05$

In Table 4, the comparison between the two groups of students before the English learning test showed that the students' pre-test scores (t = .581, p = .352 > .05) did not reach the significant level. As a result, there was no significant difference in English learning scores between Experimental group and Control group before treatment.

We can infer that the students in the experimental group and the control group had the same English scores before treatment. However, the post-test results of the two groups are compared as shown in Table 5.

Table 5. An analysis summary of independent samples test used to compare post-test scores of experimental and control groups after treatment.

Class	*N*	*M*	*Sd.*	*t*	*p*
Experimental group	60	83.531	1.539	4.613	.000
Control group	60	69.368	2.417		

$^*p < .05$

According to Table 5, the average post-test score of the experimental group was 83.531 with a standard deviation of 1.539, while the average post-test score of the control group was 69.368 with a standard deviation of 2.417. In addition, the comparative statistical results of the same questionnaire after the experiment showed that the difference in English learning between the experimental group and the control group actually reached a significant level ($t = 4.613$, $p = .000 < .05$). Apparently, students in the experimental group scored significantly higher on English study in the first part of the same questionnaire than those in the control group. Therefore, it has been proved that, in terms of English learning performance of the class, VLE has a significantly better effect on students in the experimental group than TT has on students in the same kind of control group.

4.3 Conclusion of Chapter 4

After the experiment, the experimental group's English learning achievement has changed greatly. Besides, the academic performance of students in the control group decreased significantly. Subjects identified VLE as a better way to learn, allowing them to interact and collaborate with group members so they could get help online and develop personal obligation after school.

5 Conclusions and Implications

5.1 Summary of the Major Findings and Results

The purpose of this study is to understand the impact of high school students' learning in EFL courses through the Virtual Learning Environment (VLE) approach. The results of the study prove that VLE does strengthen students' motivation in English learning, and it also effectively improves students' academic performance. The findings of this study are mainly as follows: First, the experimental group students who received VLE teaching expressed their preference for this new mentality during and after the experiment. Second, the students in the experimental group who have VLE show a high motivation for learning. Third, in the classroom of English learning, the activities and performance of the experimental group students are significantly better than the traditional teaching students.

English Learning Performance in the VLE. The experiments in this study found that the students in the traditional teaching group were evaluated by TBI during the experiment and found that the English learning scores were reduced. In contrast, the performance of the VLE experimental group students showed a significant improvement. This result proves that in the VLE learning environment, students are highly interested and enthusiastic about English learning. Because of VLE's learning environment, there are more vivid activities that students can explore, and they can be led by the students themselves. These exploratory learning processes give more learning styles and make students more fun to learn English. Moreover, in the process, the student's dominance of learning also allows students to present a higher spontaneous learning attitude.

Conclusions. Compared with traditional forms of teaching, VLE's teaching style has student-centered characteristics, coupled with online digital learning features, students have more opportunities to interact with peers, and this online interactive cooperation features, On the one hand, it can reduce the interaction between students and peers in real life, and the pressure on learning. On the other hand, students are more willing to share and cooperate with other resources. The results of this experiment also prove that, regardless of the motivation of learning and the academic performance, the teaching form of VLE does have a significant positive improvement for students' English learning.

5.2 Limitations of the Study

The research and experimental subjects were for two classes in the same grade of a high school in Taiwan. A total of 120 students were quasi-experimental design. Since the subject is limited to a single school, there are not a large number of experimental samples. In addition, due to lack of time and resources, different grading tests were not used to examine the impact of VLE on students' language proficiency. Therefore, the experimental results may not be able to infer all high school students of different regions and types.

5.3 Recommendations for Future Research

The number of subjects limited to this study is insufficient, so the promotion of the results of this study may not be comprehensive. As a result, future researchers may implement VLE on more classes to make the research more generic.

In addition, the experimental design period of this study is relatively short. For EFL teaching, it is often necessary to observe the improvement of language ability for a longer time. Therefore, in future research, it is recommended that the experimental procedure has to last for at least six months to conduct VLE teaching experiments to observe English learning motivation, attitudes, and learning achievements over a longer period of time.

What's more, in order to carry out more assessment of learning achievements, this study does not address the achievements of oral learning, listening and writing skills in language learning performance in evaluating the improvement of English learning performance in VLE. Therefore, future research can try to plan these achievements in VLE teaching design.

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Technology and Engineering Education

Encouraging Active Learning for System Engineering Students Using Role-Exchanging Activities

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Abstract. The paper intends to explain the trend of modern technologies and the challenges of system engineering education. In addition to leveraging learning-by-doing and experimental learning approaches, in the paper, we refer to the student-centered learning approach and design a role-exchanging (RE) session to encourage students to ask and to answer questions. The main objective of a RE session is to open students' brain, so that the teacher may know what students have learned from the discussion and the interaction among students. Two types of RE sessions are implemented in this research: with a time constraint and without a time constraint. Taking the "Embedded Operating Systems (EOS)" as an experimental course, we demonstrate how we implemented the two types of RE sessions. From our experience of implementation, a RE session without time constraint allows students to have a more in-depth discussion for the specified topic. However, the session may be less efficient if no proper reward policy is designed with the session. For a RE session with a time constraint, students need to prepare more questions in advance, and the teacher should involve less in the session, in which the teacher cannot explain too much if ambiguous answers were given in the Q&A in the RE session. We show our implementation of RE sessions in the paper and share the results to the teachers' community where the applicant participates so that the RE sessions can be applied to future innovative courses in system engineering education.

Keywords: Student-centered learning · Flipped learning · System engineering education

1 Introduction

Modern technologies have been evolved dramatically in the past few decades. Companies developing modern technologies led Taiwan to become a significant country for the research, development, manufacturing, and operation of new products in electronics, information, and communication. In Taiwan, most engineering students are too used to solving problems but lack the skill to transform their training and knowledge to solving engineering design problems. To push system engineering education steps forward, the Taiwan government (e.g., Ministry of Education, MOE, and Ministry of Science and Technology, MOST) financially fund some innovation projects to address

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 827–835, 2019.
https://doi.org/10.1007/978-3-030-35343-8_86

demands, challenges, and trends of the new educational technologies for system engineering courses. Then, our teaching philosophy focuses more on making students "know what they learn and know why they need to learn these." We expect students to learn to ask questions and learn to apply what they learn to real-world problems.

To follow up on the trend of modern technologies, universities have designed several system engineering courses to minimize the gaps between academics and industries. "Embedded Operating Systems (EOS)" is one of the system engineering courses offered by the Department of Electrical Engineering at National Chiao Tung University, Taiwan for that purpose. Since the course contains many abstraction concepts, "learning-by-doing" becomes one of the prevalent pedagogical methods to supplement lectures in the course. Learning-by-doing engages students in tasks similar to designing small-scale real cases and may deepen students' understanding of what they learn in the classes. However, students still feel challenging to apply what they learn to real tasks.

By observing the reaction of an Asia classroom, we figure out that the teacher stands typically in front of students, asks a question but receives a wall of the silence of reply. Asia students, especially those with system engineering backgrounds, may feel shy to raise hands in class or to participate in-class activities. Some students speak very rarely, and some of them tend to look downward. Though these students may study hard to learn to build up a standard way of thinking so that they can deal with problems with obvious answers, some of them may be lack of the ability to think critically or to face new problems with unknown solutions. Traditionally, "Understanding, Remembering and Practicing" then are firmly emphasized in building up Asia students' professional knowledge. However, understand/remember/practice some components does not mean the student can build up a system with those components. Not to mention that students may think they already understand these components, but not. A lack of full comprehension may lead students to a situation that they do not know how to apply what they learn to a real-world problem.

In this paper, we present a framework to encourage students with system engineering backgrounds to break through their old learning box, to ask more questions, and to learn how to create their learning pathways. We apply our framework to the course "Embedded Operating Systems (EOS)", one of the system engineering courses, and show the impact of the framework. In this preparatory course, Bloom's Taxonomy (Remembering, Understanding, Applying, Analyzing, Evaluating and Creating) [4–6] is applied to guide students to manage the learning outcome of each lecture class. We expect students to know what they are studying and know how to apply what they learn to face new challenges and solve problems with unknown answers.

The paper is organized as follows. Section 2 describes the syllabus, course design, and assessment of EOS. Sections 3 and 4 detail the Role-Exchanging Sessions we designed for improving the atmosphere of discussion and class interaction for EOS. Then, we conclude the paper in Sect. 5.

2 EOS

In this section, we first explain the syllabus of the EOS course, the activities, and assessments designed for the course.

2.1 Syllabus

Embedded Operating Systems is a _rst course focusing on the basic concepts of OS services, such as scheduler, task synchronization, device drivers, kernel primitives, and so on, for embedded systems.

Since an embedded operating system has to interact with various hardware-specific functions and customized features, in an application-specific way, the course objective is to guide students understand the interaction and how a programmer can apply the service provided by an operating system to solve real-world problems and obtain better performance for the specific applications. Hence, the topics covered in such a course should include:

- Overview: This part explains the architecture of OS and the relationship between hardware, OS, and application software.
- Cross Development Environment: In most cases, students are quite familiar with native programming, which is different from embedded programming. This part introduces the development environment in hosts and the toolchains for the target processors, including the cross-compiler, linker, loader, and debugger.
- Kernel Primitives of Embedded Operating Systems: This part contains the core of this course. This part introduces the hardware/software co-design, basic kernel primitives, scheduler, scheduling priorities, tasks, processes, threads, task synchronization, inter-task communication, memory management, signal, timer, _le systems, interrupts, interrupt service routines (ISR), I/O devices and drivers.
- Existing Embedded Operating Systems: This part covers the introduction of the most popular embedded operating systems, such as WinCE, Windows Mobile, Embedded Linux (uCLinux), uC/OS-II, VxWorks, Android, Firerfox OS, Tizen, and KaiOS.
- Hands-on Practices (optional): This part realizes the spirit of learn-by-doing. Though the hands-on practices can be optional to such a class, they are the realization of the above topics given in the lecture classes. With these hands-on practices, students may understand more about the development process of an embedded product or an embedded application.
- Final Project (optional): This should be a term project for a group of 2-3 students. This part can be used to enhance students ability in cooperating with others, decomposing a problem into more unaffected parts, applying SCAMPER (Substitute, Combine, Adapt, Modify, Put to other use, Eliminate, Rearrange) and CDIO (Conceive, Design, Implement, Operate) to compile group's ideas into a new design, and realizing the new design into an operable product.

2.2 Applying Bloom's Taxonomy to EOS

We apply Bloom's Taxonomy (Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating) to EOS and guide students to manage the learning outcome of each lecture class, as illustrated in Fig. 1.

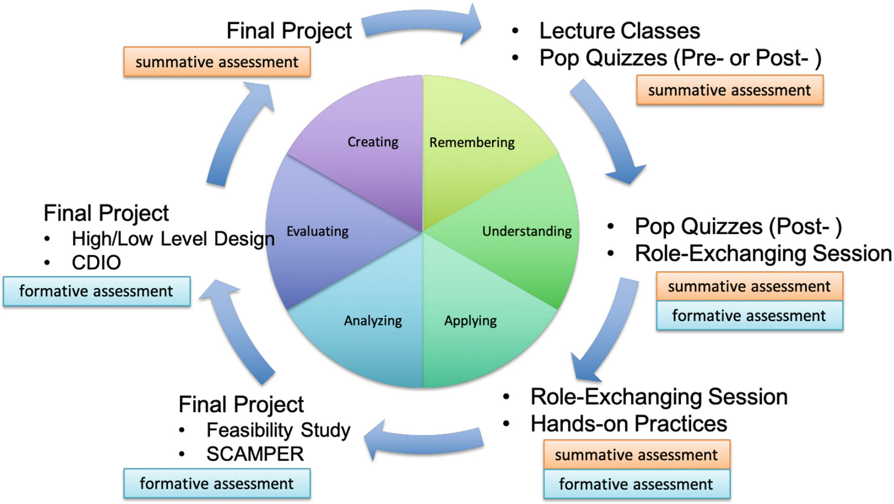

Fig. 1. Applying Bloom's Taxonomy to EOS.

In addition to the lecture classes, we may give a pop quiz in the first or the last 15 min of class time (Remembering).We name the pop quizzes a pre-quiz or a post-quiz according to the given time of the quiz. The pre-quiz is intended to give students a better understanding of the lecture, while the post-quiz can help students review the content given in the lecture. To better understand the learning effects of students, we design role-exchanging session and hands-on practices in the course. The role-exchanging session enforces students to review the previous lecture and review the essential concepts for other students in the next lecture class (Understanding). The hands-on practices leverage "learning-by-doing" to help students learn how to apply what they learn in the classes to solve a given problem (Applying). Students have to divide into groups and complete a final project, which leads them to analyze a real-world problem, evaluating the feasibility of their design and at least creating a prototype to the problem they have selected.

2.3 Assessment

A common situation that students may often encounter is, they think they already understand the lecturing content, but as a matter of fact, it is not always true. If a student knows how to ask a relevant question, we believe that the student is on track of learning and may achieve a better learning outcome. Therefore, tracking and evaluating students' learning status at any time is one of the key factors to succeeding in the course. As illustrated in Fig. 1, we also design different types of assessments for different taxonomy: summative and formative assessment. The summative assessments is adopted in the pop quizzes, the role-exchanging session, hands-on practices, and the final project. The formative assessment is applied during the semester, mainly after role-exchanging sessions, in hands-on practices and during a final project.

In Asia, summative assessment is mandatory for most courses, but the author believes that both summative and formative assessment should be taken for evaluating students' learning status. For the summative assessment, we assess students' domain capabilities by giving open-book/closed-book pop quizzes and examinations. The summative assessment can also be applied to the role-exchanging sessions mentioned above. When realizing the role-exchanging sessions in the course EOS, we count points in the group. The student-teacher can get 1 point, and the other students can get 1 point when asking questions or answering questions or providing supplementary information. However, only 1 point will be counted for a student even when the student asks more than one question. For the formative assessment, face-to-face discussion for term project design, or learning outcome evaluation by Rubrics, or questionnaires, can be adopted to review the learning effect of students. The formative assessment takes time and would be recommended for small classes. When realizing the formative assessment, we design Rubrics for the topics lectured in the quarter (just like a quarterly review) and the teacher interviews students face-to-face and one-on-one. The teacher explains to interviewees that the correctness of the answers will NOT be counted into students' final scores. Then, from the interaction, the teacher can manage the learning effects of students. In the interview, the teacher and students can also feedback to each other individually for better teaching and learning.

3 Role-Exchanging Session

Asking a good question is more important than giving out correct answers. Thus, we fuse the learning-by-doing [2], experimental learning theory [1], flipped approach [7] and student-centered learning approach [3], and design a role-exchanging session (abbreviate to RE) to exchange the role of the teacher and students. The main idea behind such a design is that students may have similar tongues. Students may understand more from other students, compared to discussions that may happen between students and teachers. In a RE session, students are divided into groups of 2–3. After each lecturing class, students in a group are required to review the lecturing contents they have learned in the previous class. Figure 2 shows the flow of the proposed RE session. Then, a lottery will be applied to randomly pick up one student as the teacher of the session (call student-teacher). The student-teacher gives a review lecture to the rest of the classmates. The student-teacher is also encouraged to investigate modern technology trends and share them with his/her classmates. After the review, the student-teacher has to answer the questions from other students. If the student-teacher does not know the answer to the question asked by students, the group member of the student-teacher can help answer the question. Other students can also give different answers or supplement the information to the question. To better analyze the performance of such a session, we divide students into four types: student-teacher (lecturer), questioner, supplementor, and those who do not take any actions.

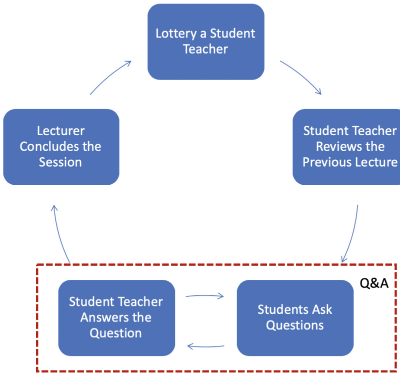

Fig. 2. The flow of a RE session.

From the interaction among the student-teacher and other students, the teacher can distinguish how much the students (including the student-teacher) understand the concept emphasized in the previous class. If the student-teacher does not know the answer to the questions, his group members can help provide answers or supplementary information. Since the student-teacher is a student, other students feel closer to the student-teacher and more willing to ask questions; moreover, the student-teacher can answer the questions in the student's tongue, which makes other students understand his explanation more. The main objective of a RE session is to open up the \black box" (students' brain), so that the teacher/lecturer (as a facilitator) may know what students have learned from the review and the interactions among students.

According to the experience of implementation, RE sessions can further be divided into two types: with and without time constraint. For a RE session without time constraint (RE-I), session duration is mainly controlled by the teacher/lecturer. The teacher can be involved in the Q&A. Notably, the teacher can help guide the student teacher to answer the questions in the right direction or correct the answers given by the student teacher. Such a session allows students to have a more in-depth discussion on the specified topic. However, when implementing a RE session without time constraint, the reward must be carefully designed. From our experience, once students get used to such a learning activity, they may not be well prepared before they attend to the lecture class. In that case, if we still implement a RE session without a time constraint associated with a reward that each student who asks questions can earn one point for his group, then students' questions may become dull, the session may be less efficient, and we cannot achieve the expected goal from the session.

For a RE session with time constraint (RE-II), session duration is fixed and should be announced in advance so that students may well-prepared before they go to the class. Since the duration is fixed, it is recommended that the teacher involves less into the session; that is, the teacher does not explain too much if the student teacher gives wrong answers or ambiguous answers. From our experience, if a fixed duration is given for a RE session, students may prepare more questions in advance.

The design of RE sessions helps students learn to study and think more when a new concept has been taught. We believe that students must have learned something before they can ask a question. From the teacher's point of view, pop quizzes show the learning effect of each student, but only surface results; RE sessions may not show the learning effect of all students, but help the teacher to dive more in investigating students' learning effect.

4 Case Study: EOS 2019 Spring

As mentioned in Sect. 2.2, the RE session is designed for enhancing the 'Understanding' and 'Applying' mentioned in Bloom Taxonomy. In the spring semester of 2019, we implemented four RE sessions in the course of EOS on 3/22, 4/19, 5/3, and 5/10, respectively. The first two RE sessions were given without time constraint (RE-I), and the third and the fourth ones were given with a time constraint (RE-II). In the first RE session (which given on 3/22), students prepared more supplementary documents related to the lecturing topics of the two sessions. In this session, students provided answers with different points of view to supplement the answer gave by the student-teacher. Such sessions are mutually beneficial as the teacher also has learned quite a lot from the questions and answers given by students.

However, on April 19, 2019, the teacher figured out that some students started to ask meaningless questions in the session to earn points for their group. All the groups earn full credits in that session, which means that we are not able to give a distinguishable assessment for students. The teacher figured out the fact and announced that the subsequent RE sessions will be given with a time constraint and encouraged students to prepare more in the next session. In the third RE session implemented in the spring semester of 2019, as expected, students were more active in the classroom. In that session, some group got zero points, which means that students of the group were not well-prepared before coming to the class. More, as illustrated in Fig. 3, the number of supplementors (the dashed line) went to zero in the two RE-II sessions.

Since only thirty minutes were given in the second RE session, students needed to have their questions well prepared in advanced. In the session, the atmosphere of the classroom was taut because the clock was ticking. The questions were skipped if the student-teacher could not answer them correctly. Other students might not have time to search for the answers on the Internet and given their opinion. In this case, the teacher would have to document these unanswered questions and explained them later after the session. However, since the teacher does not deeply be involved in the Q&A and discussion, the teacher cannot correct the ambiguity of concepts in real-time. and the learning effect of the students might result poorly.

In the final examination, the teacher proved the above results. The teacher composed the examination based on the questions asked and answered by students in both RE-I and RE-II sessions. As a result, from the answer sheets, students did such poorly on those questions from RE-II compared to the RE-I session. As mentioned above, the teacher explained questions and answers after the RE sessions were over for RE-IIs.

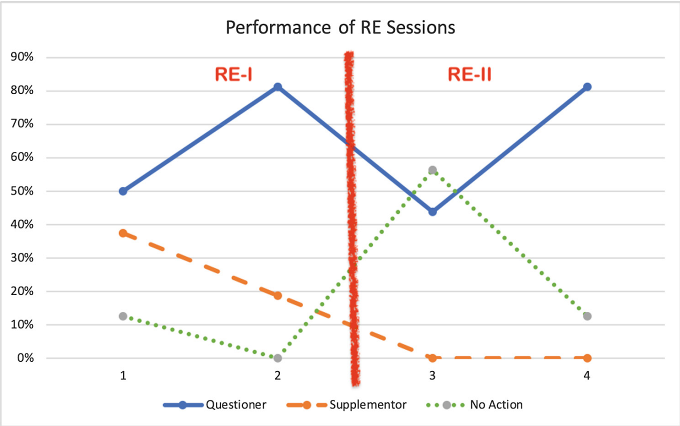

Fig. 3. The performance of RE sessions given in 2019 spring.

The teacher concluded that it might be because students already lost their focuses when the explanations were given after RE-II sessions. From the answer sheets of the final examination, the teacher figured out that students only remembered the keywords but not the details for the answers given after the RE-II sessions. In contrast, RE-I sessions resulted in better performance on the final examination. Because the questions were answered and explained during the sessions, instead of those after RE-IIs. It may be harmful when dealing with kernel programming if students do not understand these details.

5 Conclusions

The paper presents the RE session we design based on the four approaches, learning-by-doing, experimental learning, student-centered learning, and learning, to encourage students to ask and to answer questions. The main objective of a RE session is to open up students' brains, so that the teacher may know what students have learned. We have implemented two types of the proposed RE session in the experimental course, "Embedded Operating Systems (EOS)": with a time constraint and without a time constraint.

From the experience of the implementations, the RE session without time constraint (RE-I) allows students to have a more in-depth discussion on the specified topic. However, the session may be less efficient if we implement a RE session without a time constraint associated with improper reward policy. In such a case, students' questions may become dull, and we cannot achieve the expected goal in the session. More, the teacher might not be able to distinguish students' learning effects, as mentioned in Sect. 3.

For the RE session with time constraint (RE-II), students need to prepare more questions in advance, and the teacher should involve less in the session, in which the teacher is not allowed to explain too much if ambiguous or wrong answers were given in the Q&A in the RE session. In such a case, the teacher cannot correct the ambiguity in real-time. The teacher has to take notes right when he/she figures out that the answer is improper or incorrect, and then the teacher can give correct answers when concluding the session.

By observing the interaction of RE sessions, we find that the student-teacher handling the RE session can present a concept using students' tongue, and perhaps that since the student-teacher is a student, other students feel closer to the student teacher and more willing to ask questions. Compared to pop quizzes, the author thinks that the RE sessions bring more learning effects to students.

From the answers given for the questions of the final examination, we figure out that students learn more from the RE-I sessions and can give more details for the questions. For the answers to the questions related to topics discussed with RE-II sessions, students only remember keywords but not the detail.

We then recommend that the award policies of the RE sessions should be modified to give questioners and supplementors with different credits. More credits can also be given to students who ask 'good' or 'interesting' questions. It might be helpful to inspire students to interact with each other during a role-exchanging session.

Acknowledgement. This research was partially supported by the Ministry of Education, Taiwan and Ministry of Science and Technology, Taiwan, under the grand PEE1080337 and MOST 105-2511-S-009-018-MY3, respectively. We thank our colleagues from the Center for Teaching and Learning Development, National Chiao Tung University, who provided insight and expertise that greatly assisted the research. We especially thank Dr. Ze-Ni Huang, for her comments that significantly improved the manuscript.

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Employability Table for Mechanical and Mechanical College Students in Science and Technology Colleges After Graduation: Analysis of Employability of Graduates and Employers

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Abstract. The purpose of this study is to explore the employability of the Department of Mechanical Engineering of the National Science and Technology School after graduation, and to study the employers of social freshmen and machinery-related enterprises who graduated from the Department of Mechanical Engineering within five years. with regard to mechanical related abilities, general common abilities, and behavioral attitudes. The correlation between the three major employment performances. The research target is 123 fresh people from the country who have graduated within five years of student and 112 employers people from all over the country. Graduates use Employability Table for Mechanical and Mechanical College Graduation in Science and Technology Colleges self-assessment of core employability performance. The Employers uses Employability Table for Mechanical and Mechanical College Graduation in Science and Technology Colleges to assess the graduates' employment performance. The results of the study show that there are significant differences between graduates and employers in terms of the three major employability-oriented items, and the scores of graduates are generally higher than those of employer. Finally, based on the research findings, this study proposes relevant suggestions for improving the core employment and future research of college students.

Keywords: Employability Table · Department of Mechanical Engineering · Graduates' employment performance

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 836–846, 2019.
https://doi.org/10.1007/978-3-030-35343-8_87

1 Introduction

In recent decades, the generalization of universities and science and technology universities has promoted the national knowledge level and promoted the development of the social knowledge economy. However, the low employment rate after graduation is worrying, and the employment problem of college graduates is gradually affected by society attention. De Vos et al. [1] pointed out that. Workers' employability is obtained through the acquisition of knowledge, skills, abilities, and other characteristics that are valued by current and prospective employers and thus encompasses an individual's career potential. It can therefore be regarded as an important factor in understanding contemporary career success. Therefore, how to improve the employment of college students has become the policy focus of higher education in many countries. Chiou [2] It is pointed out that in the era of rapid economic changes, higher education should strengthen students' employability. Dhanavel [3] also pointed out that the need to equip graduating students with the skills essential for the workplace has become an urgent concern. Recently, in order to strengthen the University of Science and Technology in the promotion of students' employability, they have actively proposed innovative ways through various channels, such as industry internships, corporate visits, teacher-integrated teaching, and industry-themed collaborations. The purpose is to hope for various ways of intervention through the school. This will enable students to have higher employability before leaving the campus to enter the workplace. All of the above are to improve the employment in the general direction. There is no analysis of the employer's expected employment and then improvement. This study hopes to make further suggestions for the school's teaching methods by analyzing the differences between the students' perceived employment and the students' self-assessment of employment.

2 Literature Review

2.1 The Significance and Connotation of Employability

Employability refers to the ability to be at work, and its ability is not only technology or skill, but the behavioral attitude required to face things. Chin, Chuang [4] pointed out that the employability refers to the degree of knowledge, skills, work attitude and career planning that an individual need to acquire. Obtain and protect his work when he or she is employed for employment, and to be successful in the work profession. Yang [5] point out that employability is the ability of individuals to get jobs, keep jobs, and get work done.

National Youth Commission, Executive Yuan [6] entrusted scholars to conduct college graduate employment evaluation, the core employment power is divided into three categories: work attitude and cooperation ability, career planning and learning and enterprising and professional knowledge application ability. Knowledge, technology, abilities, attitudes and other factors (KSAOs) are sources of individual employability. In addition, the industry employers believe that the qualities that graduates need are the ability of the individual to work [7–9]. Therefore, the employability of this study is assessed by the three major structures of specific skills and knowledge-related abilities, general abilities, and behavioral and attitudinal traits. Research graduates and industry employers should have the employability for graduates of the University of Science and Technology mechanical group.

2.2 Employers' Discussion on Employability

For employers in the industry, graduates lack the face of the employability required by the industry. Employers have been in opinion that graduates are not prepared venturing the complexities and stressful situations of working environment [10–12]. Andreas and Hiroshi [13] addressed the skills considered to be important by employers during the recruitment process. It was proved through factor analysis that employers perceived soft skills (core employability skills and communication skills) to be very important and the engineering graduates lacked these skills. It was emphasized that engineering institutions should improve the skill set of graduates realizing the importance of soft skills and focus on assessing the skills during teaching-learning process. Employability skills can also be defined as the transferable skills needed by an individual to make them employable. Along with appropriate technical understanding and subject knowledge, employers often outline a set of skills that they want from an employee. Those skills are what they believe will equip the employee to perform their role to the best in their capability [14].

According to the above research, employers' expectation of graduates' employment ability, in addition to basic professional skills. Pays more attention to the soft power of students, that is, the attitude and behavior of dealing with things, so this study is about behavior/attitude. Study the characteristics of the above and discuss and make recommendations.

3 Research methods

3.1 Research Design

The purpose of this study is to explore the self-assessment of employability of graduates of mechanical sciences in science and technology schools. And employers assess the employability of graduates of the Department of Mechanical Engineering. Compare the differences between the two and discuss. For the purpose of this research, this study uses the questionnaire survey method and theoretical analysis method to conduct the "Employability Table for Mechanical and Mechanical College Students in Science and Technology Colleges after graduation- graduation student Questionnaire", and the "Employability Table for Mechanical and Mechanical College Students in Science and Technology Colleges after graduation-Enterprises Questionnaire". Independent sample t-test and reliability analysis were conducted on 123 graduate questionnaires and 112 corporate questionnaires.

Participants in the questionnaire included 123 graduates from various mechanical science and technology departments in the country, and 112 domestic and mechanical related business executives.

3.2 Questionnaire Design

Employability Table for Mechanical and Mechanical College Students in Science and Technology Colleges After Graduation

Based on the perspectives on the relative importance of employability skills form by John et al. [15] this is added after the addition and modification of the item Scale. The table is divided into three facets, which cover the abilities of specific skills and knowledge, the general abilities and the traits of behavioral attitudes. Among them, in the "specific skills and knowledge-related capabilities" facet, increase "cost analysis capabilities", "transform ideas and concepts into written records", "practical technology in the field of mechanical expertise", "speaking in the machinery industry", "Workplace Safety and Health", "Sensitivity of Machinery Industry Change", "Looking for Resource Capabilities", "Speed and Direction Sensitivity", "Space Stereo Construction Capability", "Diversity and Individual Differences", " Accuracy focus analysis ability" 10 items. In the "behavior/attitude traits" facet, add "innovative thinking ability", "employment spirit", "common sense" and "acceptance and feedback" four items, the total item is 50 questions, all aspects. The assessment of the employment power of graduates. The employment strength table of students in the mechanical field of science and technology colleges is shown in Table 1.

Table 1. Employability Table for Mechanical and Mechanical College Students in Science and Technology Colleges after graduation.

Dimension	Indicator
1. Specific skills and knowledge-related capabilities" facet, increase	1-1 Broad general knowledge
	1-2 Cross-disciplinary thinking/ knowledge
	1-3 Field-specific theoretical knowledge
	1-4 Field-specific knowledge of empirical/practical methods
	1-5 Foreign language proficiency
	1-6 Computer skills
	1-7 Understanding complex social, organizational and technical systems
	1-8 Planning, coordinating and organizing
	1-9 Applying rules and regulations
	*1-10 Cost analysis capabilities
	*1-11 Transform ideas and concepts into written records
	*1-12 Practical technology in the field of mechanical expertise
	*1-13 Speaking in the machinery industry
	*1-14 Workplace Safety and Health
	*1-15 Sensitivity of Machinery Industry Change
	*1-16 Looking for Resource Capabilities
	*1-17 Speed and Direction Sensitivity
	*1-18 Space Stereo Construction Capability
	*1-19 Diversity and Individual Differences
	*1-20 Accuracy focus analysis ability

(*continued*)

Table 1. (*continued*)

Dimension	Indicator
2. General ability	2-1 Problem-solving ability
	2-2 Analytical competencies
	2-3 Numerical abilities
	2-4 Learning abilities
	2-5 Reflective thinking, assessing one's own work
	2-6 Creativity
	2-7 Working under pressure
	2-8 Accuracy, attention to detail
	2-9 Time management
	2-10 Negotiating
	2-11 Physical and mental fitness for work
	2-12 Manual skills
	2-13 Working independently
	2-14 Ability to work in a team
3. Behavior/attitude traits	3-1 Initiative
	3-2 Adaptability
	3-3 Assertiveness, decisiveness, persistence
	3-4 Power of concentration
	3-5 Getting personally involved
	3-6 Loyalty, integrity
	3-7 Critical thinking
	3-8 Oral communication skills
	3-9 Written communication skills
	3-10 Tolerance, appreciation of different points of view
	3-11 Leadership
	3-12 Taking responsibilities, decisions
	3-13 Innovative thinking ability
	3-14 Employment spirit
	3-15 Common sense
	3-16 acceptance and feedback

*New add item.

4 Results and Discussions

4.1 Graduate Questionnaires

In this study, the fresh people who graduated from the Department of Mechanical Engineering within five years. Use the Likert 5-point scale to evaluate your employability. And use the SPSS statistical software package to analyze the recycling questionnaire. Table 2 is the graduate background analysis results. Of the 123 samples. Most of the graduation time samples were within three years. National schools accounted for 85.4% of the distribution of graduate school attributes. accounting for most of the school attributes. In the sex segment. males accounted for 79.7% of all samples. For mechanical graduates, this proportion reflects the gender differences in the field of mechanical learning.

Table 2. Graduate questionnaires background analysis results.

	Graduate questionnaires	
	Times	Percentage
1. Graduation time		
1 year	43	35%
2 year	43	35%
3 year	11	8.9%
4 year	9	7.3%
5 year	17	13.8%
2. School attributes		
National	105	85.4%
Private	18	14.6%
3. Sex		
Male	98	79.7%
Female	25	20.3%

The results show that the Cronbach's α values of the three facets in Table 4 are .911, .922, and .933, respectively, which are greater than .9. Therefore, all three facets have very good reliability. The average number of 50 employment projects is higher than 3, indicating that graduates' self-employability assessment has a middle-to-middle awareness. The four broads of "general knowledge", "space stereoscopic construction capability", "diversity and individual differences" and "precision, depth and focus analysis skills" in the "abilities related to specific skills and knowledge" The average number of projects is even greater than 4. This phenomenon represents that students in these four employment projects believe that their performance is good. Overall, the society freshmen who graduated from the Department of Mechanical Engineering of the University of Science and Technology have their own employment in the workplace. Performance is satisfactory, and I believe that my performance is in the middle.

4.2 Corporate Questionnaires

In this study, employers of machinery-related companies used the Likert 5-point scale to assess the employability of graduates. And using the SPSS statistical software package to analyze the recycling questionnaire, and Table 3 is the background analysis of employer background. Among the 112 samples. the highest education of employer. most of them are college graduates. They can have some understanding of the university curriculum. In the sex component, males account for 75.9% of all samples. For mechanical graduates. this proportion reflects the gender differences in the field of mechanical learning. In the company scale. large scale of enterprise for 40.2% of all samples, small and medium scale of enterprise accounted for 24.12%. Small scale of enterprise accounted for 35.7%, indicating that the scope of the questionnaire is wide, not limited to a certain size of the enterprise, in the position of the position, the supervisor more than the average employee, but there is not much difference.

Table 3. Corporate questionnaires background analysis results

	Corporate questionnaires	
	Times	Percentage
1. Education		
Master's degree	28	25.0 %
University	81	72.3 %
High school	3	2.7 %
2. Sex	85	75.9 %
Male	27	24.1 %
Female	85	75.9 %
3. Company scale		
Large scale of enterprise	45	40.2 %
Small and medium scale of enterprise	27	24.1 %
Small scale of enterprise	40	35.7 %
4. Position		
Supervisor	61	54.5 %
Staff	50	44.6 %
Other	1	0.9 %

The results show that the Cronbach's α values of the three facets in Table 4 are .895, .926, and .932, respectively, which are close to or greater than .9. Therefore, these three facets have very good reliability. The average number of 50 employability projects is higher than 3, indicating that employers believe that the employer's employability is in the middle, and only the average of the "learning ability" of the "general ability" facet. Even greater than 4, this phenomenon means that the employer of the enterprise only believes that the graduates perform well in one employment project. On the whole, the employer believes that the social freshmen who graduated from the Department of Mechanical Engineering of the University of Science and Technology have a job performance in the workplace. It is medium and not particularly prominent.

4.3 Comparative analysis of employers and graduates

The results of the study show that, as shown in Table 4. there are only "interdisciplinary thinking/knowledge" in the "abilities related to specific skills and knowledge", "practical knowledge in the field of mechanics", "computer skills" and "thinking ideas and concepts". The average number of the four employability projects is that the employer of the enterprise is larger than the graduates. It is obvious that the graduates are more self-conscious than the employability that the employers are more employable. Among them, "theoretical knowledge of the mechanical field", "understand complex society, organization and technical system", "plan, coordinate and organize work tasks" in the face of "abilities related to specific skills and knowledge", etc. The 12 employment forces are significant, and the t value is negative, which means that among the 12 employment power projects, the self-perception of graduates' employability is higher. The self-perception is higher, and in the "general ability" facet, only the two "employment ability" and "creativity" are not significant students. Other than the employer of the enterprise, other employment projects are also the graduates' self-assessment is significantly higher than the employer's perception. Finally, in the "behavior/attitude traits" facet, there is only "verbal communication ability". The three employability projects, "Writing Communication Skills" and "Leadership", are not significant students who feel that they are higher than employers. Other employability projects are also that graduates' self-assessment is significantly higher than that of employers.

Table 4. Analysis of Corporate questionnaires and Graduate questionnaire.

	Corporate questionnaires		Graduate questionnaires		*t*	*Sig.*
	Mean	*SD*	*Mean*	*SD*		
1. Specific skills and knowledge-related capabilities" facet, increase (Corporate Cronbach 's α = .895, Graduate Cronbach 's α = .911)						
1-1 Broad general knowledge	3.94	.525	4.03	.639	−1.250	.213
1-2 Cross-disciplinary thinking/ knowledge	3.74	.732	3.74	.651	.014	.989
1-3 Field-specific theoretical knowledge.	3.64	.781	3.97	.652	−3.469	.001
1-4 Field-specific knowledge of empirical/practical methods	3.77	.735	3.60	.797	1.657	.099
1-5 Foreign language proficiency	3.27	.816	3.35	.789	−.780	.436
1-6 Computer skills	3.98	.759	3.95	.745	.315	.753
1-7 Understanding complex social, organizational and technical systems	3.30	.745	3.60	.856	−2.833	.005
1-8 Planning, coordinating and organizing	3.28	.750	3.63	.823	−3.469	.001
1-9 Applying rules and regulations	3.37	.723	3.45	.898	−.765	.445
*1-10 Cost analysis capabilities	3.09	.812	3.24	.823	−1.448	.149
*1-11 Transform ideas and concepts into written records	3.72	.713	3.71	.733	.168	.867
*1-12 Practical technology in the field of mechanical expertise	3.56	.825	3.85	.836	−2.682	.008
*1-13 Speaking in the machinery industry	3.32	.713	3.85	.840	−5.131	.000
*1-14 Workplace safety and health	3.57	.835	3.88	.785	−2.892	.004
*1-15 Sensitivity of machinery industry change	3.17	.734	3.55	.842	−3.728	.000

(*continued*)

Table 4. (*continued*)

	Corporate questionnaires		Graduate questionnaires		*t*	*Sig.*
	Mean	*SD*	*Mean*	*SD*		
*1-16 Looking for resource capabilities	3.46	.919	3.95	.711	−4.593	.000
*1-17 Speed and direction sensitivity	3.70	.745	3.91	.789	−2.133	.034
*1-18 Space stereo construction capability	3.68	.785	4.11	.612	−4.621	.000
*1-19 Diversity and individual differences	3.41	.742	4.11	.584	−7.926	.000
*1-20 Accuracy focus analysis ability	3.46	.920	4.09	.690	−5.851	.000
2. General ability (Corporate Cronbach 's α = .926, Graduate Cronbach 's α = .922)						
2-1 Problem-solving ability	3.63	.796	4.12	.567	−5.468	.000
2-2 Analytical competencies	3.79	.650	4.07	.616	−3.471	.001
2-3 Numerical abilities	3.58	.790	3.85	.587	−2.897	.004
2-4 Learning abilities	4.11	.575	4.17	.623	−.810	.419
2-5 Reflective thinking, assessing one's own work	3.82	.647	4.29	.569	−5.943	.000
2-6 Creativity	3.88	.686	3.95	.612	−.900	.369
2-7 Working under pressure	3.78	.898	4.29	.733	−4.845	.000
2-8 Accuracy, attention to detail	3.64	.889	4.11	.675	−4.461	.000
2-9 Time management	3.63	.959	4.02	.593	−3.712	.000
2-10 Negotiating	3.22	.975	3.73	.840	−4.264	.000
2-11 Physical and mental fitness for work	3.54	.909	3.86	.793	−2.838	.005
2-12 Manual skills	3.65	.975	4.04	.772	−3.368	.001
2-13 Working independently	3.50	1.040	4.03	.689	−4.582	.000
2-14 Ability to work in a team	3.75	.788	4.15	.544	−4.535	.000
3. Behavior /attitude traits (Corporate Cronbach 's α = .932, Graduate Cronbach 's α = .933)						
3-1 Initiative	3.68	.988	4.17	.721	−4.325	.000
3-2 Adaptability	3.78	.694	4.12	.608	−4.038	.000
3-3 Assertiveness, decisiveness, persistence	3.58	.834	3.99	.763	−3.933	.000
3-4 Power of concentration	3.85	.893	4.19	.682	−3.246	.001
3-5 Getting personally involved	3.93	.768	4.37	.578	−5.051	.000
3-6 Loyalty, integrity	3.56	.803	4.26	.584	−7.552	.000
3-7 Critical thinking	3.51	.759	3.73	.850	−2.111	.036
3-8 Oral communication skills	3.78	.596	3.92	.753	−1.591	.113
3-9 Written communication skills	3.91	.623	4.02	.600	−1.322	.187
3-10 Tolerance, appreciation of different points of view	3.51	.805	4.16	.578	−7.087	.000
3-11 Leadership	3.78	.596	3.92	.753	−1.591	.113
3-12 Taking responsibilities, decisions	3.17	.804	4.07	.733	−8.932	.000
3-13 Innovative thinking ability	3.76	.604	4.01	.695	−2.920	.004
3-14 Employment spirit	3.72	.961	4.36	.589	−6.035	.000
3-15 Common sense	3.54	.929	4.37	.604	−8.033	.000
3-16 acceptance and feedback	3.62	.762	4.29	.539	−7.787	.000

5 Conclusions

In this study, through the above analysis, 50 employment and graduate employment projects were compared. I hope to make further suggestions for the school's teaching methods by analyzing the differences between the students' perceived employers' and the students' self-assessment of employability.

1. 12 kinds of employment powers such as "theoretical knowledge in the field of machinery", "understanding complex society, organization and technical system", "planning, coordinating and organizing work tasks", and "practical technology in the field of mechanical profession" are the self-feeling of graduates. Compared with the employer's opinion, the ability of the graduates to recognize themselves in these 12 employments has not yet met the requirements of the employer.
2. In the "General Competence" facet, 12 employment forces such as "problem solving ability", "analytical ability", "computing ability" and "self-work evaluation" are also considered by graduates to be more self-perceived than employers think. On behalf of the 12 employers who have a "general ability" facet, the ability of graduates to recognize themselves has not yet met the requirements of employers.
3. In the "behavior/attitude traits" facet, 13 initiatives such as "initiative", "adaptation", "confidence, decisiveness, persistence" are also considered to be higher than the employer's self-perception. In the 13 general employments of the "general ability" face, the ability of graduates to recognize themselves has not yet met the requirements of employers.

From the above three points, we can see that the overall employability performance of graduation has not reached the expectations of employers, and there is a gap in theory, attitude, and practice. The phenomenon of the drop in the use of learning still exists. The two employability of "computer skills" and "converting ideas and concepts into written records" are not significantly different, but as can be seen from the average, the evaluation of enterprises in these two employability are slightly higher than that of graduates. Self-evaluation shows that in the era of rapid development of science and technology, graduates still have a certain degree of certainty in the relatively novel field skills.

Acknowledgements. I am grateful to the Ministry of Science and Technology, Taiwan, for its support and funding for this research; Project Number (MOST 107-2511-H-018-013 and MOST 108-2511-H-018-014).

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The Development of Simulation-Based Laboratory Lessons in Electronics Industrial Instrumentation to Enhance Ill-Structured Problem Solving for Engineering Students

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Abstract. This study investigates the efficacy of the simulation-based laboratory lessons in electronics industrial instrumentation to support both knowledge and problem solving skill of engineering students. This study focused on developing of simulation-based laboratory lessons in electronics industrial instrumentation to enhance ill-structured problem solving for engineering students. The result revealed that the designing framework consist of the component called "Simulation Laboratory" which can activate cognitive structure and enhance Ill-structured problem solving. The other focus, this study aimed to compare the effectiveness of simulation-based laboratory versus traditional laboratory. The result revealed that there is no significant difference for both laboratories. The finding of this study indicate that is possible to use the simulation-based laboratory instead of traditional laboratory to reduce constraint of equipment investment, specific time and space.

Keywords: Simulation-based learning · Constructivist · Electronics industrial instrumentation

1 Introduction

Nowadays, the new technology is evolving rapidly, especially in the industrial engineering. Thus, the needed skill in the future will be complex problem-solving capability, namely, the ability to resolve novel or ill-defined problems under complex circumstances in reality. Therefore, engineering students have to develop knowledge and skill. The engineering education need to prepare students to practice engineering [1]. The laboratories are enable engineering students to practice and experiment to promote students' understanding. However, the equipment in engineering laboratories are costly, especially in industrial instrumentation i.e. equipment costing more than $10,000. Moreover, engineering students have a limit time, two or three hours each experimental, and they have to wait until next week. Furthermore, teacher or laboratory assistant may be required during experiment to coach and answer questions [2].

The simulation-based laboratory (SBL) is a promising tool for supporting engineering students in complex and dynamic systems. This is an efficient and effective

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 847–853, 2019.
https://doi.org/10.1007/978-3-030-35343-8_88

teaching for engineering education [3]. There are not limited to one specific time and place. The SBL also reduce cost of expensive equipment. Furthermore, the importance benefit of SBL is that they can operate and manipulate any parameters without risk in both body injury and equipment damage. Another advantages of SBL are flexibility, explanation of theoretical concept, and repetition [4]. That could be a great benefit for engineering education.

Here, we demonstrate the combination of SBL with ill-structured problem solving process to enhance knowledge and problem solving skill for engineering students. The instructional design and development of SBL is described. Moreover, a preliminary result comparing the traditional laboratory learning and SBL is reported.

2 Purposes

The purposes of this study are to develop the simulation-based laboratory lessons in electronics industrial instrumentation to enhance ill-structured problem solving for engineering students and to compare the students' understand of electronics industrial instrumentation between SBL and traditional laboratory learning.

3 Methodology

3.1 Participants

The participants in this study were 30 undergraduate students of electronics and telecommunication engineering department, Rajamangala university of technology Isan, Khon Kaen campus, Thailand, who enrolled in a course of electronics industrial. The 1st semester, 2018 academic year. The participants ages were 21–23 years old. Then, participants were divided to experimental groups (15 students) and control group (15 students).

3.2 Research Instruments

- For evaluation of simulation-based laboratory lessons in electronics industrial instrumentation to enhance ill-structured problem solving for engineering students was used the expert review recording for examination the quality in 3 domains as follows: contents, instructional design, and media.
- For assessment pre- and post-students' understand of electronics industrial instrumentation were used a written test of laboratory and theory knowledge.

3.3 Data Collecting and Analysis

- The evaluation of simulation-based laboratory data was collected by using the expert review recording for examination the quality. Summarization, interpretation and analytical description were used to analyze the data.

- Participants in both control and experiment group were explained about the written test before perform the pre- and post- written test. Then, the pre- and post-test scores were analyzed with independent sample *t* tests.

4 Results

4.1 Designing Framework

The designing framework of the development of simulation-based laboratory lessons in electronics industrial instrumentation to enhance ill-structured problem solving for engineering students consist of activating cognitive structure and promoting ill-structured problem solving of engineering students. It illustrated the underline theories used in design the component called **"Simulation Laboratory"**. The underlined theories used for activating cognitive structure were as follows: Cognitive constructivism [5] cognitive conflict, situated learning [6]; Authentic context. These theories were transformed into practice as problem situation in order to induce the learners into discovery learning process. The 7 step of problem solving [7] as following: Step 1: Learners Articulate Problem Space and Contextual Constraints Step 2: Identify and Clarify Alternative Opinions, Positions, and Perspectives of Stakeholders Step 3: Generate Possible Problem Solutions Step 4: Assess the Viability of Alternative Solutions by Constructing Arguments and Articulating Personal Beliefs Step 5: Monitor the Problem Space and Solution Option Step 6: Implement and Monitor the Solution Step 7: Adapt the Solution. The simulation [8] was used for manipulation and testing validation of parameters. They were transformed into practice as learning task in order to promote problem solving. Thus, simulation laboratory may help activating cognitive structure and problem solving of the engineering student. The designing framework of the activating cognitive structure and promoting ill-structured problems solving (see Fig. 1).

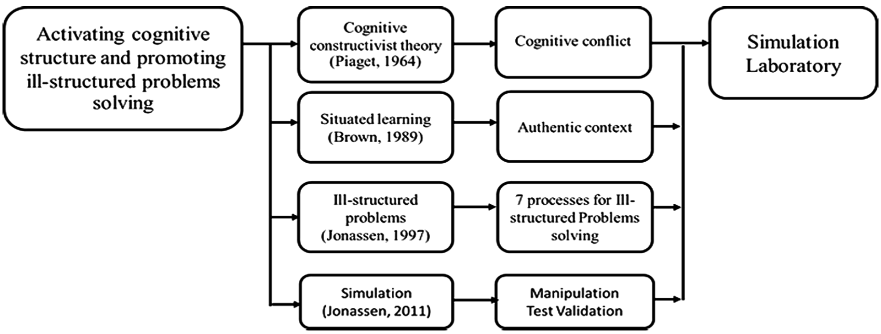

Fig. 1. The designing framework: activating cognitive structure and promoting ill-structured problems solving.

The **"Simulation Laboratory"** contains the situation with ill-structured problem, which were adapted from the ill-structured problem solving process [7]. Then, designing tasks and engineering students will be asked to solve problem tasks about electronics industrial instrumentation. For example, engineering students were assumed to be Maintenance engineer, which is responsibility to check the machine. During daily check machine, there are pressure alarm from boiler. Thus, engineering students are asked to solving problem by following below processes.

- **Learners articulate Problem Space and Contextual Constraints.** The first step in the ill-structured problem solving process is identifying the appropriate problem space which contain the possible states of the problem, the problem operators, and the problem constraints. Then, engineering students will write the problem space into the experimental handbook.
- **Identifying the real problem.** After engineering students identify the appropriate problem space. They have to analyze and identify what does the problem really exists. Usually, the ill-structured problems have divergent or alternative solutions. Therefore, they should identify all stakeholders and their goals. Then, they should identify all of the various perspectives, views, and opinions on that problem, and then, identify the real problem. After that, they must record data into the handbook.
- **Generate Possible Problem Solutions.** Due to ill-structured problems have multiple representations of the problem. Thus, there are multiple solutions. The engineering students will generate, identify and select or synthesize a solution by construction their own mental model of the problem. After that, they must record into the experimental handbook.
- **Assess the Viability of Alternative Solutions.** For this step, engineering students will use the simulation laboratory for assessing the possible solution to test their concepts of controlling pressure or hypothesis. The simulation laboratory will contain situation in real world such as damage sensor or pressure gauge which cannot send pressure data to the server. Then, engineering students will record results into the handbook.
- **Planning and monitor the Problem Space.** After select the possible solution from step 4, they should make problem solving plan carry out that plan. For instance, they must planning cost and human resource for repairing. Then, setup schedule time with agreement for all department. After that, provides evidence of metacognition and record into the handbook.
- **Implement and Monitor the Solution.** While engineering students implement the solution, they should monitor performance of sensors or pressure gauge which they repaired or controlled such as checking the LED indicator on the panel that work properly and record into the handbook.
- **Adapt the Solution.** After Implementation the solution, engineering students will get the feedback from previous step. And then, they may use feedback for adjustment and adaptation. Finally, they record into the handbook.

4.2 The Simulation-Based Laboratory Lessons in Electronics Industrial Instrumentation to Enhance Ill-Structured Problem Solving for Engineering Students

The result of the development of simulation-based laboratory lessons in electronics industrial instrumentation to enhance ill-structured problem solving for engineering students.

The simulation-based laboratory of pressure gauge instrument consist of pressure gauge, tank level, boiler temperature, and LED indicator for alarm (see Fig. 2).

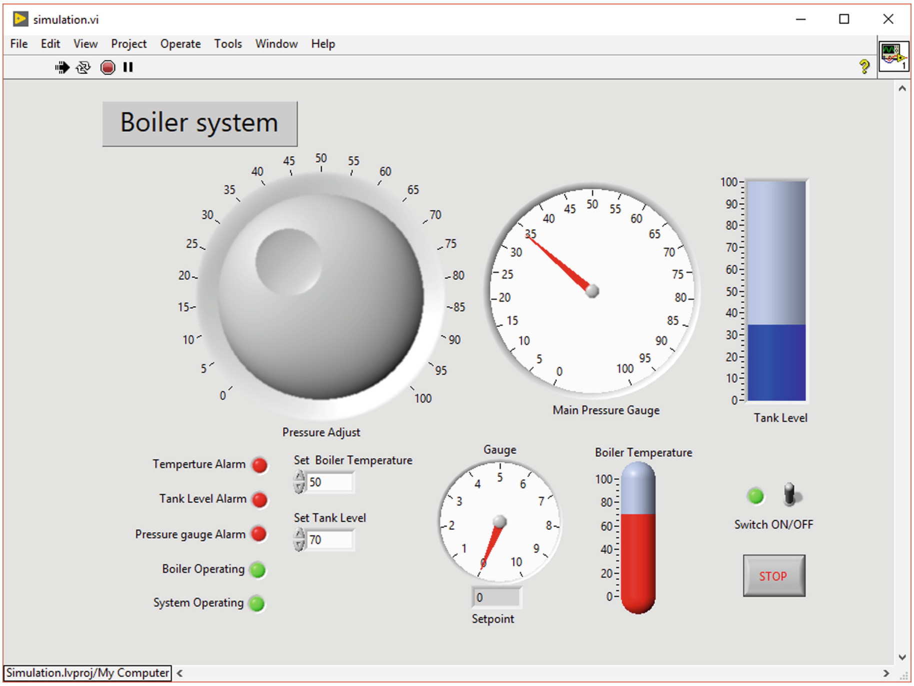

Fig. 2. An illustrative example of simulation-based laboratory of pressure gauge instrument.

The result of examination of the simulation-based laboratory by the experts, the internal validation of the model, shows that the designing of model is appropriate and congruent with the underlined theories and principles. Learning theories used in this research are Cognitive constructivist [5], Situated learning [6], Ill-structured problem solving [7] and Simulation [8]. Those theories used as foundation in the design of the model can enhance both knowledge construction and ill-structured problem solving.

4.3 Effectiveness of the Simulation-Based Laboratory Versus Traditional Laboratory

Pre- and post-test were used to measure students' understand to learn electronics industrial instrumentation before and after participating in both simulation laboratory and traditional laboratory activities by using written tests. The hypothesis of this experimental is no significant difference between students who use the simulation-based laboratory versus traditional laboratory for practice in electronics industrial instrumentation course.

Table 1. *t* test results of the simulation-based laboratory and traditional laboratory.

Measure	Simulation-based laboratory			Traditional laboratory			*t* test	
	n	*M*	*SD*	*n*	*M*	*SD*	*T*-score	*p* value
pre-test	15	8.00	2.98	15	8.73	2.89	0.68	0.499
post-test	15	16.13	0.83	15	15.60	1.80	−1.04	0.312

The *t* test revealed that there was no significance difference between the pre-test scores for simulation-based laboratory students ($M = 8.00$, $SD = 2.98$) and for traditional laboratory students ($M = 8.73$, $SD = 2.98$), T-score = 0.68, $p < 0.05$. Similarly, there was no significance difference between the post-test scores for simulation-based laboratory students ($M = 16.13$, $SD = 0.83$) and for traditional laboratory students ($M = 15.60$, $SD = 1.80$), T-score = −1.04, $p < 0.05$, as shown in Table 1. This result indicates that the students were not significantly different for both simulation-based laboratory and traditional laboratory in their understanding of the electronics industrial instrumentation.

5 Conclusion

This study was descripted the development simulation-based laboratory environment lessons in electronics industrial instrumentation to enhance ill-structured problem solving for engineering students. The designing framework consist of foundation theories such as cognitive constructivist, situated learning, simulation, and ill-structured problems, which was applied from the ill-structured problem solving process [7] as following processes: (1) Learners articulate problem space and contextual Constraints. (2) Identifying the real problem. (3) Generate possible problem solutions. (4) Assess the viability of alternative solutions. (5) Planning and monitor the problem space. (6) Implement and the solution. (7) Adapt the solution. This finding was consistent with Yampinij [9] Wattanachai [10] these previous research found that the students showed their ill-structured problems solving. This may help learners to enhance ill-structured problems solving.

Furthermore, the effectiveness of the simulation-based laboratory versus traditional laboratory was compared. The results show that no significance difference between simulation-based laboratory and traditional laboratory. This research result consistent with study of Campbell et al. [2] which show the simulation laboratory and traditional laboratory was no significant difference on the written test. The implications of this finding as follow: Engineering student can accessible the simulation laboratory in anywhere, either university or home. They also can accessible in anytime which they want to learn. Simulation-based laboratory may reduce cost for equipment and laboratory space investment.

Acknowledgements. This research was supported by Ph.D. Program in Educational Technology, Faculty of Education, Research Group for Innovation and Cognitive Technology, Khon Kaen, University, and Research and Technology Transfer Affairs Division, Khon Kaen University which hereby giving the thankfulness all through this.

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Teaching Propositional and Syllogistic Logic Using E-learning Tools

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Abstract. This paper is a study of the use of E-learning tools in a course on basic logic. It is a continuation of earlier studies involving practical experiments with students of communication using the Syllog system for syllogistic reasoning. In the present study, we also discuss the use of the Proplog system which we developed to support a part of the course dealing with basic propositional logic. Both systems make it possible to do learning analytics based on logged data. The aim of the present paper is to investigate whether various log-data from the use of the two E-learning tools can be helpful in order to improve the quality of the logic teaching. Furthermore, it is discussed how the use of the tools can be integrated in the logic course including the exam.

Keywords: Syllogistics · Argumentation · Learning analytics · Logical proofs · Deduction · Gamified quizzing · Logic teaching

1 Introduction

In this paper we discuss problems and teaching challenges related to courses in basic logic and argumentation offered to 2nd year students in “communication and digital media” at Aalborg University in Aalborg and Copenhagen. The present study is a continuation of previous studies and practical experiments, cf. [6–9] in which the effect of the lectures on Syllogistics have been measured as precisely as possible using logged data from the students’ use of the system Syllog, implemented in PROLOG+CG; cf. [3–5, 11–14].

In the present study, a slightly revised version of Syllog (with a stronger emphasis on the gamification aspects) has been used to evaluate the effects of an improved version of the lectures on syllogistics. Furthermore, in the present study we also present a new tool, Proplog, designed to be used together with the lectures on basic propositional logic. This new tool makes it possible for the student to explore basic propositional reasoning, and it also allows the teacher to evaluate the effect of the lectures on this kind of reasoning. In Sect. 2 we briefly introduce the present content of the lectures on syllogisms. In Sect. 3 the results based on the log-data, generated by the student’s use of the Syllog system, are presented and discussed. In Sect. 4 we briefly introduce

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, pp. 854–864, 2019.
https://doi.org/10.1007/978-3-030-35343-8_89

the present content of the lectures on basic propositional logic and the new system Proplog. In Sect. 5 the results based on the log-data generated by the student's use of the Proplog system, are presented and discussed. In Sect. 6 we briefly present some further reflections on the use of Syllog and Proplog in our logic course. In Sect. 7 we present some conclusions and offer some directions for further research.

Although all log-data are anonymous we have chosen to ask the students to approve the collection and use of log-data from their use of the systems. All of the students have accepted.

2 Aristotelian Syllogisms as a Deductive Structure

Aristotelian syllogistics has been an essential part of almost all courses in basic logic since the rise of the European university in the 11th century; cf. [1] and [10]. In our modern context we are making use of the system, Syllog, cf. Fig. 1.

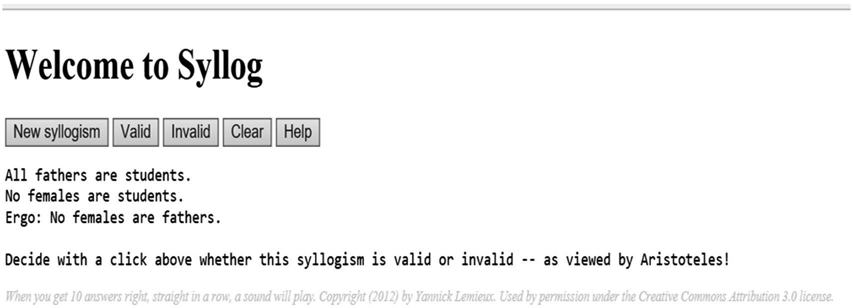

Fig. 1. The interface of the Syllog system used in 2019. The user can click on "New syllogism" to get a new syllogism presented on the screen. Then the user will have to decide whether the syllogism presented is valid or invalid, i.e., whether or not the conclusion follows necessarily from the premises (in any possible/thinkable scenario). The systems allow for some kind of gamification or completion, since a sound will play when the group obtains 10 right answers in a row. - When using "New syllogism" in Syllog we have decided to let the valid patterns occur just as frequently as the invalid. As mentioned above, the students were asked to work with Syllog in small groups of 2–3 persons each for about 15 min before the theoretical lectures on syllogistic were given, and also to use the system for some time after the lectures. See [14].

In the medieval interpretation of the Aristotelian ideas on syllogisms, four so-called figures are taken into account. In a modern context these figures (or patterns) can be presented in the following way:

AFig1:	x(M,P)	AFig2:	x(P,M)	AFig3:	x(M,P)	AFig4:	x(P,M)
	y(S,M)		y(S,M)		y(M,S)		y(M,S)
Ergo:	z(S,P)	Ergo:	z(S,P)	Ergo:	z(S,P)	Ergo:	z(S,P)

Here M, P and S stand for categories of "things" (broadly speaking), and x, y and z all belong to the set of the following four linguistic structures:

a ("all _ are _")
i ("some _ are _")
e ("no _ are _")
o ("some _ are not _")

It is obvious that these four structures are logically related:

$$\mathrm{e}(\mathrm{U},\mathrm{V}) \equiv \mathrm{not}\,\mathrm{i}(\mathrm{V},\mathrm{U}) \quad [\text{i.e. } \mathrm{e}(\mathrm{U},\mathrm{V}) \text{ and } \mathrm{i}(\mathrm{V},\mathrm{U}) \text{ are mutual contradictions}]$$
$$\mathrm{a}(\mathrm{U},\mathrm{V}) \equiv \mathrm{not}\,\mathrm{o}(\mathrm{V},\mathrm{U}) \quad [\text{i.e. } \mathrm{a}(\mathrm{U},\mathrm{V}) \text{ and } \mathrm{o}(\mathrm{V},\mathrm{U}) \text{ are mutual contradictions}]$$

It is easy to see that it is possible to form 256 patterns using these four linguistic structures for x, y, z in the figures AFig. 1-4. According to the classical theory, 24 of these patterns are valid, whereas the remaining 232 patterns are invalid.

In our lectures on syllogistics, it was strongly emphasized that the validity in question is a formal concept. This means that the precise concepts which S, P, M, U, V etc. actually stand for are unimportant when it comes to the question of validity. All we need in order to decide on a question of validity has to do with the abstract pattern or structure. If a syllogism is valid it can be demonstrated using a few obvious principles.

The first of these principles is (TRANS) according to which the combination of "All U are V" and "All V are W" entails that "All U are W". Obviously, this implies that the so-called "barbara of AFig.1" with (x, y, z) = (a, a, a) is valid. Given that "No X are Y" is equivalent with "All X are non-Y", (TRANS) also means that the so-called "celarent of AFig1" with (x, y, z) = (e, a, e) is valid. In short, there are two ways of using (TRANS):

$$[\mathrm{a}(\mathrm{U},\mathrm{V})\,\&\,\mathrm{a}(\mathrm{V},\mathrm{W})] \rightarrow \mathrm{a}(\mathrm{U},\mathrm{W})$$
$$[\mathrm{a}(\mathrm{U},\mathrm{V})\,\&\,\mathrm{e}(\mathrm{V},\mathrm{W})] \rightarrow \mathrm{e}(\mathrm{U},\mathrm{W})$$

Another very obvious principle, (MUT), allows us to change the order of the concepts in e- and i-expressions, i.e.

$$\mathrm{e}(\mathrm{U},\mathrm{V}) \equiv \mathrm{e}(\mathrm{V},\mathrm{U})$$
$$\mathrm{i}(\mathrm{U},\mathrm{V}) \equiv \mathrm{i}(\mathrm{V},\mathrm{U})$$

It is obvious that if one of these two equivalences is accepted, the other follows from the fact that i(U, V) can be defined as the negation of e(U, V).

A final principle, (EX), is based on the idea that if all U are V, then it follows that some (at least one) U is V, i.e., it allows us to deduce i(U, V) from a(U, V), and also to deduce o(U, V) from e(U, V). Again, given that e(U, V) can be read "All U are non-V", it is obvious that the two deductive possibilities are equivalent.

Using indirect proofs ("reductio ad absurdum"), the validity of all 24 valid syllogisms can be demonstrated using the principles (TRANS), (MUT) and (EX). A syllogism like the one shown in Fig. 1 should be formalized before any decision on its validity is made. Since this syllogism uses (x, y, z) = (a, e, e), and since it is obviously the Aristotelian figure, AFig2, the actual validity question is whether or not the syllogistic pattern with the linguistic structures (a, e, e) in AFig2 is valid. In fact it is, and in classical syllogistics, logicians speak of "camestres of AFig2" (with the vowels of the artificially constructed word "camestres" referring to the (a, e, e)-order of the linguistic structures in the argument). This means that the student, when answering this question of validity, should ignore the fact that S, P and M here stand for "females", "fathers" and "students", and should instead concentrate on proving that "camestres of AFig2" is a valid pattern.

However, it might not be quite evident why this particular pattern is valid. Does e(S, P) actually follow from a(P, M) and e(S, M)? In order to verify that this is the case, we assume the conjunction of the premises and the negated conclusion, and show that these assumptions lead to a contradiction when we use the three principles:

1.	a(P, M)	Premise
2.	e(S, M)	Premise
3.	not e(S, P)	Negation of the conclusion "camestres of AFig.2"
4.	e(M, S)	By 2 and (MUT)
5.	e(P, S)	By 1, 4 and (TRANS)
6.	e(S, P)	By 5 and (MUT). This contradicts 3.

In some cases, the proof becomes more complicated. It might be because the structure is more complex, or because the (EX)-principle is involved as well – or both. The following demonstration of an example of a proof which at least is one step longer.

1.	e(M, P)	Premise
2.	a(M, S)	Premise
3.	not o(S, P)	Negation of the conclusion "felapton of AFig.3"
4.	a(S, P)	By 3
5.	a(M, P)	By 2, 4 and (TRANS)
6.	o(M, P)	By 1 and (EX)
7.	not a(M, P)	By 6. This contradicts 5

In this way the validity of 24 syllogisms can be demonstrated. On the other hand, it turns out that none the 232 remaining patterns are provable, which means that it is possible that the premises hold along with the negation of the conclusion.

The 24 valid syllogisms, as named in classical, medieval syllogistics, can be grouped as follows by their four figures:

AFig1: barbara, celarent, darii, ferio, barbarix, feraxo
AFig2: cesare, camestres, festino, baroco, camestrop, cesarox
AFig3: darapti, disamis, datisi, felapton, bocardo, ferison
AFig4: bramantip, camenes, dimaris, fesapo, fresison, camenop

The task for the Syllog users is then to decide whether the syllogism actually presented on the screen corresponds to one of the provable patterns listed above. It is, of course, important that the deductive results are not just seen as an arbitrary list, but rather as a necessarily following consequence of some basic logical properties.

In our lectures, the students were taught both the logical properties presented above, and how to use them to prove the validity or invalidity of a given syllogism.

3 The Syllog Results

A student's ability to do logic reasoning can be analysed in terms of a score calculated on the basis of log-data from the use of Syllog. This score is calculated as:

$$Score = correctanswers/answercount \tag{1}$$

The score measures how well the user is doing in evaluating the validity of logical arguments. Logic teaching is, at least in part, aimed at raising this score. Therefore, we measured the scores both before the lectures (pretest) and after the lectures (posttest) using the log-data logged by Syllog. This is done by asking the students to work with Syllog in small groups of 2–3 persons each for about 15 min before and after the lectures.

The statistical analyses of the scoring data were performed using standard methods from descriptive statistics and statistical testing. Student t-tests and Cohen's d effect size were used to determine whether there was a substantial difference between pretests and posttests. The following Cohen's conventions were applied: 0.2 = small effect, 0.5 = medium effect, and 0.8 = large effect [15]. The quantitative data were analysed with MS Excel (Windows).

An interesting question concerns the students' competence to evaluate the validity of syllogisms before receiving formal training on this subject [6–8]. In the previous studies we have provided evidence to the effect that the students' ability to distinguish between valid and invalid syllogisms before the teaching starts is significantly higher than the level of guessing. The value of this early score appears to be rather stable from year to year during the period 2012-15. The studies suggest 0.61 as the average value of this early score.

As was mentioned above, the score was measured in both a pretest before the lectures on the subject, and a posttest after the lecture. The aggregated results and the scores are shown in Table 1.

Table 1. Summarizing counts from the 2019 course of how well student groups scored in the tests immediately before the lectures (pretest) and immediately after (posttest). These values may be compared with the score before the teaching starts, 0.61 (suggested by earlier studies).

Syllog	Score mean (*SD*)	Time mean
Pretest (N = 65 groups)	0.67 (0.16)	47.5
Posttest (N = 40 groups)	0.80 (0.20)	70.0
t-test	*p*-value = 0.0009***	
Effect size	0.72	

***Significant at the 0.001 level (2-tailed).

The results support strong statistical evidence (p-value = 0.0009) against the presumption that student will handle the syllogisms equally well before and after the introduction of the subject. The effect size as measured is strong to medium (d-value = 0.72).

Data from groups which answered fewer than five questions were excluded from the measurements; thus the N = 68 and N = 40 groups in the pretest and posttest do not include the groups which answered so few questions that their scores would not be meaningful.

As can be seen readily, the results show a significant improvement in the scores between pretest and posttest.

Nevertheless, the dropout was 38% between the pretest and the posttest, and this will reduce the validity of the results. To elaborate further on this, we compared the 40 best groups from the pretest, with the 40 groups in the posttest. The result still came out in favour of the posttest (effect-size = 0.28, p-value = 0.08).

The score is higher this year than in previous years, both on the pretest and the posttest, possibly because the students worked in groups, not individually. The posttest also shows significantly higher scoring than the pretest, and this may also be explained by valuable discussion of the theory within the groups. Our hypothesis is thus that solving this kind of logic problems in interactive groups has a positive effect on the learning outcome. The groups also used more time in the posttest, possibly to discuss each exercise.

It should be noted that in our first studies of log-data from Syllog (i.e., [6] and [8]), the analyses gave no statistical evidence against the presumption that students handle the syllogisms equally well before and after the lecture on syllogistics. Thus the students could not be proven to have improved (or worsened) their performance by having received formal instruction. However, this result was taken as an important indication of the need to improve the quality and the focus of the teaching in order to obtain a higher degree of learning. As we learned from the study in [7], the introduction of gamified quizzing in Syllog can in fact lead to better results. The present study suggest that an emphasis on the deduction structures, as taught in this year's course, may also give rise to significantly better results. It is also likely that the extra time used in the post-test was spent in order to discuss the properties of the syllogistic structures in more detail, which may indicate that learning could be improved if problems are solved in groups in a collaborative manner.

4 Teaching Propositional Logic Using Proplog

Recently, we have developed a new system, Proplog, designed to be used in our course in basic logic as a supplement to Syllog. The structure and use of Proplog are very similar to Syllog. Thus a student who has previously worked with Syllog will be able to use Proplog right away. Again, the system will present valid and invalid arguments with equal probability. This distribution of questions means that it is very easy to see if the student can evaluate propositional arguments at a level better than guessing. All the propositions in Proplog have to do with Adam and Eve being at home or not being at home. Furthermore, the system uses negation, implication, conjunction, and disjunction (Fig. 2).

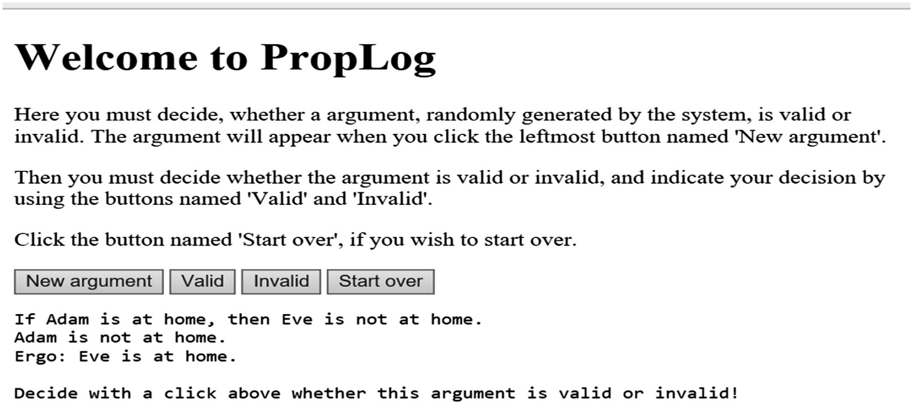

Fig. 2. The interface of the Proplog system used in 2019. The user can click on "New argument" to get a new problem presented on the screen. See [14].

In the lectures on basic propositional logic, the students were briefly introduced to the history of propositional logic and to some of the classical problems in propositional logic. Furthermore, they were introduced to the use of truth-tables of the classical logical connectives. Finally, the students were introduced to the use of semantical trees in order to handle questions of validity.

5 The Proplog Results

A student's ability to do logic reasoning can be analysed in terms of the score calculated on the basis of log-data in the same way as for Syllog (see Sect. 3 above for the precise definition of the score).

As with Syllog, the students worked in groups of 2–3 persons each for about 15 min, and the score was measured before the theoretical lectures (pretest) and again as soon as possible after (posttest). Again, data from groups which had answered fewer than five questions were excluded from the measurements.

In the propositional logic learning, the student groups showed initial scores similar to the syllogistic part, as shown in Table 2. It is important to note that the students are able to evaluate propositional arguments at a level significantly higher than the level of guessing.

It is, however, somewhat disappointing that the there is no improved score from pretest to posttest. Apparently, the lectures had no effect on the students' ability to evaluate the validity of propositional arguments. The student groups in Aalborg and in Copenhagen (aggregated together in Table 2) showed similar results. The lectures might of course have other qualities which cannot be measured in this way, but it should not be ignored that a better understanding of the validity of propositional arguments is one of the important goals and expected learning outcomes in the logic course.

The results can be summarised as in Table 2:

Table 2. Summarizing counts from the 2019 course of how well student groups scored on the propositional logic questions in the beginning of this teaching period and immediately after this period.

Syllog	Score mean (SD)	time mean
Pretest (N = 69 groups)	0.65 (0.15)	37.7
Posttest (N = 48 groups)	0.64 (0.17)	95.2
t-test	*p*-value = 0.67	

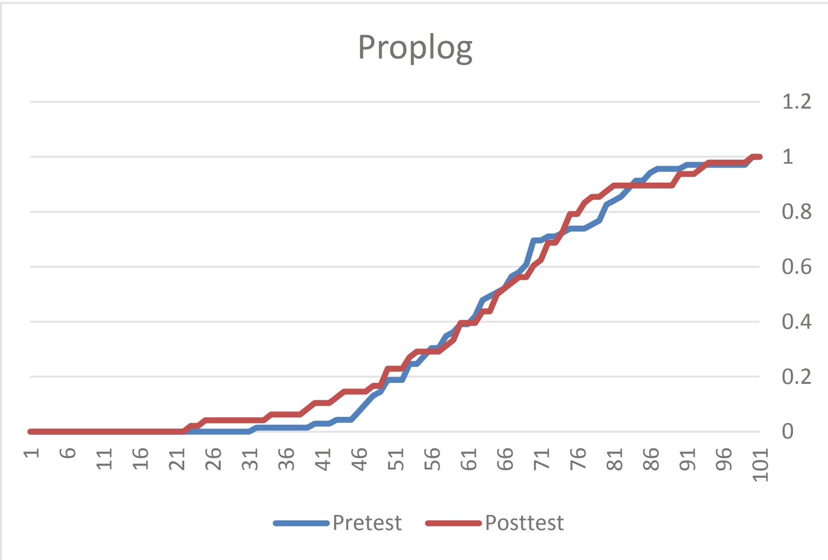

Fig. 3. Plots showing the cumulative distribution of scores in Pretest and Posttest.

Although there might be several possible ways to explain this unexpected result, and although the material presented in the course might be difficult to remember (cf. [2]), any teacher obtaining a result of this kind should in fact consider whether a change in the teaching strategy is in order. As reported in Table 2, the students used significantly longer time in the posttest to reflect on the problems presented by Proplog. This suggests that they are actually trying to benefit from the theoretical lectures, although it also appears that what they have learned from the lectures does not help them when they are trying to evaluate the validity of the propositional arguments presented by the Proplog system. As it might even be observed from Fig. 3 above, several students had a low score (<0.2) in the posttest. One possible explanation is that a number of students lose their motivation and are close to giving up.

Based on the information from the log-data it is obvious that the content of the lectures in question should be revised. More emphasis should be put on logical and practical techniques that can actually help the students when they want to evaluate the validity of a propositional argument. A further suggestion is provided below, after we have described the results from the exam.

6 Syllog and Proplog Used in the Logic Course

As one of the tasks on the written exam, the students were asked to pick a couple of valid and invalid syllogistic and propositional arguments from the Syllog and Proplog systems, and to explain why the arguments in question are valid or invalid. In their explanations the students were asked to refer to the theoretical concepts and ideas from the course. This part of the exam was clearly very useful and almost all of the students were able to answer this part of the test in a fully satisfactory manner.

This result suggests that more emphasis should be made in the teaching on having the students solve practical exercises in propositional logic, by reasoning on paper (real or digital) about the problem. Formal propositional logic, as taught in our course, may be regarded as a subfield of mathematics, and therefore the didactic method of mathematics will likely apply, despite our students being students in the humanities. As D.E. Knuth says in his famous work, The Art of Computer Programming: "It is difficult, if not impossible, for anyone to learn a subject purely by reading about it, without applying the information to specific problems and thereby being encouraged to think about what has been read." [16]. Knuth's book is concerned with teaching concepts from both mathematics and computer programming, and the sentence quoted above is from a section encouraging readers to enrich their learning experience by solving some of the exercises given in the book. With Knuth, we believe that learning by doing is an important tool in the learner's methodological toolbox, and thus we believe that future courses on propositional logic should be redesigned to include more exercises for students to solve, perhaps in writing, both inside and outside the classroom.

7 Conclusions

In this study, we have presented two e-learning tools, Syllog and Proplog, for use in the teaching of logic. The systems are beneficial both to the students, who get hands-on experience with solving practical problems in logic, and to their teachers, who get quantitative feedback on the effect of their teaching.

We have used this feedback in the past to improve our teaching on syllogistics, and the results demonstrate a measurable improvement in the students' ability to solve problems in deciding the validity of syllogisms. Similarly, the recently introduced Proplog system has revealed that we must revise the structure and content of the part of the logic course dealing with propositional logic, in order to help the students attain their learning outcomes. Moreover, the nature of the data has also helped us deduce possible avenues of improvement to our teaching strategy.

In this way, the importance of e-learning systems which provide logging of student activity are seen to have a measurable effect on the quality of the teaching. The use of the log-data by the teachers to improve their teaching is thus a process of iterative optimization, driven by learning analytics. By studying the learning analytics, and making necessary adjustments to the teaching strategy, teachers can demonstrate a measurable improvement in the learning outcome.

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Correction to: Innovative Technologies and Learning

Lisbet Rønningsbakk, Ting-Ting Wu, Frode Eika Sandnes, and Yueh-Min Huang

Correction to:
L. Rønningsbakk et al. (Eds.): *Innovative Technologies and Learning*, LNCS 11937, https://doi.org/10.1007/978-3-030-35343-8

In Chapter "Visual Attention Analysis During Program Debugging Using Virtual Reality Eye Tracker":
The original version of this chapter was revised. The affiliation of the authors listed the incorrect country. It was corrected to "Taiwan, Republic of China."

In Chapter "A Systematic Literature Review of Qualitative Gamification Studies in Higher Education":
The original version of this chapter was revised. Corrections, which were not incorporated during the proofing stage due to a technical error, were incorporated. These corrections affected citations, references, and an author's affiliation. Typographical errors were also corrected and the email addresses of all authors were added.

The updated version of these chapters can be found at
https://doi.org/10.1007/978-3-030-35343-8_11
https://doi.org/10.1007/978-3-030-35343-8_52

L. Rønningsbakk et al. (Eds.): ICITL 2019, LNCS 11937, p. C1, 2019.
https://doi.org/10.1007/978-3-030-35343-8_90

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