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Maiga Chang · Elvira Popescu · Kinshuk · Nian-Shing Chen · Mohamed Jemni · Ronghuai Huang · J. Michael Spector · Demetrios G. Sampson *Editors*

Foundations and Trends in Smart Learning

Proceedings of 2019 International Conference on Smart Learning Environments

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Preface

Smart learning environments are emerging as an offshoot of various technology-enhanced learning initiatives that have aimed over the years at improving learning experiences and outcomes by making learning more efficient through creating learning space and atmosphere that meet the individual needs of learners, while still enabling learners to access digital resources and interact with learning systems at the place and time of their choice.

The concept of what constitutes smart learning is still in its infancy, and the International Conference on Smart Learning Environments (ICSLE) is organized by the International Association on Smart Learning Environments and has emerged as the platform to bring together researchers, practitioners, and policy makers to discuss issues related to the optimization of learning environments to enhance learning. The focus is on the interplay of pedagogy, content knowledge, technology and their interactions and interdepencies towards the advancement of smart learning environments.

ICSLE will facilitate opportunities for discussions and constructive dialogue among various stakeholders on the limitations of existing learning environments, need for reform, innovative uses of emerging pedagogical approaches and technologies, and sharing and promotion of best practices, leading to the evolution, design and implementation of smart learning environments.

The focus of the contributions in this book is on the challenges and solutions in smart learning and smart learning environments that researchers have faced and proposed. Various components of this book include but are not limited to:

- Assessment in smart learning environments
- Innovative uses of emerging and existing technologies
- Learning analytics, technologies and tools to support smart learning environments.

ICSLE 2019 received 45 papers, with authors from 16 countries. All submissions were peer-reviewed in a double-blind review process by at least 3 Program Committee members. We are pleased to note that the quality of the submissions this year turned out to be very high. A total of 10 papers were accepted as full papers (yielding a 22.22% acceptance rate). In addition, 9 papers were selected for presentation as short papers and another 7 as posters.

Furthermore, ICSLE 2019 features joint activities with US-China Smart Education Conference and presents 3 distinguished keynote presentations. An Ed Tech Ascend Pitch Competition, a tutorial on Observational Studies and Learning Analytics and a panel of Academia-Industry Collaboration are also included in the program. One workshop is also organized in conjunction with the main conference, with a total of 2 accepted papers (included in this volume).

We acknowledge the invaluable assistance of the 62 Program Committee members from 23 countries, who provided timely and helpful reviews. We would also like to thank the entire Organizing Committee for their efforts and time spent to ensure the success of the conference. And last but not least, we would like to thank all the authors for their contribution in maintaining a high quality conference.

With all the effort that has gone into the process, by authors and reviewers, we are confident that this year's ICSLE proceedings will immediately earn a place as an indispensable overview of the state of the art and will have significant archival value in the longer term.

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January 2019	

Contents

A framework for designing an immersive language learning environment integrated with educational robots and IoT-based toys

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Abstract. In view of the benefits of and success in acquiring multiple languages in an immersive learning environment while young, this research aims to create an immersive language learning environment for young children to acquire multiple languages utilizing robots and IoT (Internet of Things) -based toys. This paper presents the results from the first two stages of this project aiming to develop a design framework to guide the development of such an immersive environment. Our extensive review of the relevant literature indicates that the framework should, at least, consist of five main pedagogical considerations: language input, activity design, interaction design, toy design and robot design. In each of the five dimensions, a number of key factors should also be addressed in creating an effective learning environment. The development of the design framework is to serve as a road map providing design principles and guidelines for educators and researcher to create an immersive learning environment.

Keywords: Design framework. Educational robot. IoT-based toys. Immersive language learning environment

1 Introduction

Being multilingual offers benefits beyond communication. A large body of research in language education has been devoted to learning a foreign or second language. These studies have proposed important pedagogical strategies and have demonstrated the learning benefits obtainable by with the support of technology. But learning a second language through such a conscious learning process [1, 2] is known to result in less accuracy and lower proficiency in comparison to acquiring one's own native language [3-5]. Consequently, many have investigated the advantages of acquiring multiple languages the same way as learning a mother tongue when young.

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Immersion education is an educational model in which the target language is used for instruction in the class for students to learn specific subject matters. The purpose of immersion education is to immerse young children in a target language and culture, providing them with opportunities to use the target language as a pathway to become bilingual. In actuality, however, most children lack access to an immersive multilingual environment during their critical period of language development. Moreover, creating an immersive language environment for young children in a non-target language culture is challenging in many aspects.

This study proposes to create an immersive multilingual environment utilizing robotic and IoT technology for preschool children, who are in the critical period of language and cognitive development, to become bi- or multilingual. As studies have pointed out that play is essential to toddlers' daily life and that play has significant positive effects on enhancing children's cognitive development, including language skills [6-8], it is proposed that the immersive language environment be implemented in a play scenario at home. In such an environment, while children play with their toys, the robot plays the role of a companion or a caregiver, interacting with the children and providing linguistic feedback as parents would do, but in a target language.

However, the development of an immersive language environment is complicated in that many factors need to be taken into consideration. Therefore, the need for a comprehensive design framework is urgent. The purpose of this study is to develop a design framework for young children's immersive language acquisition through incorporating robots and IoT-based toys. In this study, literature reviews on five important areas concerning children's cognitive and language development have been carried out, to identify critical design factors, to propose a design framework and some key design guidelines. This study aims to answer the following questions:

Q1: What are the dimensions that should be taken into consideration in designing an immersive learning environment through the incorporation of a robot and IoT-based toys?

Q2: What are the factors at play in each dimension?

2 Method

This study adopts a design-based research (DBR) approach for the development of the framework. We have completed phase 1, in which we identified the practical issues in acquiring a second language and the need for an immersive language learning environment. We are now in phase 2, proposing a design framework for immersive language learning utilizing robots and IoT-based toys This framework will be evaluated in an iterative cycle of testing and refining in phase 3 and 4. However in this paper, we will focus on phase 1 to 2 only, that is, needs assessment and development of the design framework.

This study collected data regarding the design factors and principles though literature review on language acquisition, children's language development, children's cognitive development, robot-child interaction, child-toy interaction and immersive language education. The data were categorized by three researchers.

3 Preliminary results

3.1 Results of research question 1

Figure 2 shows that the framework has learners' needs and characters as its core, which include age, gender and cognitive style and capacity among others. The five dimensions to be considered are all centered around learners' needs and characters. They are: language input, activity design, interaction design, toy and robot design. The immersive language learning environment is proposed to be designed in the following order: selecting the application domain (language input), designing learning content including activity and interaction, and designing hardware that is, toys and the robot.

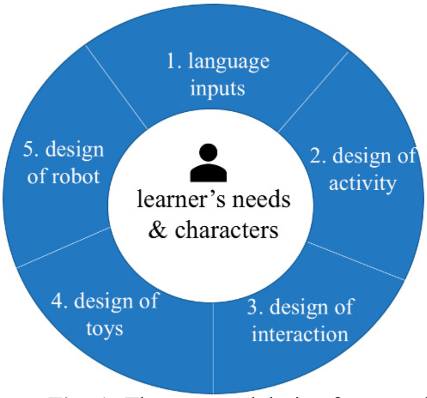

Fig. 1. The proposed design framework

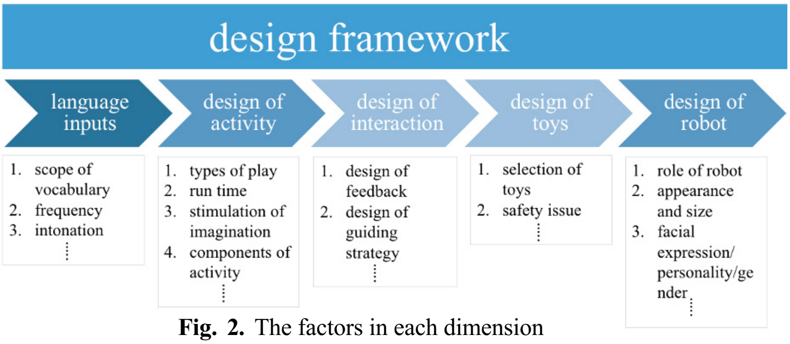

Fig. 2. The factors in each dimension

3.2 Results of research question 2

Figures 2 shows the main dimensions of the framework and the main factors in each dimension. Language input includes the following factors such as scope of vocabulary, the input frequencies and intonation. The activity design could include the principles and factors that contribute to the design of a successful learning activity, including selecting types of play that fit learners' cognitive development, how long the run time should be, the important components to be included in the activity. Interaction design concerns with the principles that help to engage learners in interacting with the robot and the toys. Design of toys should consider the selection of toys and principles for hardware and software selection and design. The design of the robot should focus on the roles of the robot, the appearance, size and facial expressions in relation to the different roles that the robot is going to play. All the above considerations should be informed by learners' needs and characteristics.

4 Conclusion remarks

The research presented in this paper is still in the developmental stage, and more research is underway to explore other factors that facilitate or impede such a technology-supported immersive language environment. Further data will be collected when this framework is implemented, to facilitate the cycle of testing and refining.

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A Framework of Learning Activity Design for Flow Experience in Smart Learning Environment

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Abstract. With the progress of technology, the smart learning environment focusing on technology enhanced learning has been concerned by more and more researchers. By combining the key elements of smart learning environment with flow theory, this study proposed a framework of learning activity design that can be applied in smart learning environment. It is hoped that the framework could increase the chance of the appearance of flow experience in the learning process of smart learning environment. They could obtain an enjoyable learning experience as well as enhance their immersion and engagement. Hence, learners would learn pleasantly and effectively in the activity, thus promoting their personal development.

Keywords: Learning Activity Design；Flow Experience；Smart Learning Environment.

1 Introduction

There is a great deal of literatures on the study of teaching strategies based on Smart Learning Environment (SLE). In current situation of SLE, Li et al., [1] found that learning experience in SLE becomes more visualized and abundant. However, Gong et al., [2] found that learners in primary SLE have six non-engagement behaviors such as "gain advantage by trickery", distraction, change of learning goals, out of focus, careless, laziness and cheating. In 1982, Pace [3] found that learners with high learning engagement were more likely to obtain high achievement and diagnostic for understanding various relationships. Shi and Salamonson et al., [4,5] also believed that learning engagement can influence learners' ability to get knowledge and self-

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learning, and then influence learners' development. Therefore, the study of learners ' experience and learning engagement in SLE is in the request of the digital generation learners, and it is also an important direction of SLE in the future for a long time [2]. The focus of learners' learning experience and engagement is to enable teachers to make full use of the advantages of SLE to design appropriate and effective learning content and learning activities. Consequently, learners can devote themselves to a learning space with the intelligent technologies. They could also study enjoyably and effectively, and then promote their personal development.

It has been a long time since the appearance of flow which focus on learners' experience. Many scholars have done a lot of research based on Csikszentmihalyi's study, including the application of flow in the field of education [6,7]. Qin [6] found that flow can effectively solve or alleviate the contradiction and improve learning performance. Qian [7] also proved that flow experience can improve learners' cognitive ability, language ability and communication competence in some degrees. Flow experience is an enjoyable experience with deep concentration which would make learners ignore external interference, enjoy the enjoyment of the learning task in classroom. Hence, the theory of flow is also widely used in educational games [8,9]. Kiili [8] hold that the aim of educational games was to facilitate learners' experience so that learners would be engaged to activities to enhance learning. In another empirical study, Li et al., [9] chose an educational game based on the knowledge of security first aid, it was also found that there was a significant positive correlation between flow experience and learning performance.

Through the previous studies of SLE and flow experience, it is found that the aim of both them are to enhance learners' learning experience and promote learners' learning performance. There seem have many literatures about SLE and flow experience, but the effect of improving learners' learning experience is not significant. In order to solve the problem of low immersion and low engagement of learners in learning activities, we combine the six elements of SLE (Learning resources, Intelligent tools, Learning community, Teaching community, Learning style and Teaching method) [10] with the three antecedent conditions of flow experience (Goals, Feedback, Skills match challenges) [11,12] to design a framework of learning activities, hoping to effectively meet the learners' demand for learning experience and high engagement. As a result, learners could make full use of the convenience provided by educational technology tools in SLE, eliminate the interference from external, focus on the value of activities themselves, and get an enjoyable and involved learning experience.

2 Literature Review

2.1 Flow Experience

The conception of flow was originally presented by Csikszentmihalyi in 1960. Through a study of a few hundred experts, artists, athletes, musicians, chess masters and surgeons, Csikszentmihalyi discovered that they are almost engrossed in their work, ignoring the passage of time and the surrounding environment, fully involved in the context with deep concentration. Csikszentmihalyi (1990) has described flow as follows: *"Flow is the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it."*

Csikszentmihalyi described eight conditions of flow in 1990 [11] and later updated it to nine [13]: 1) Goals Are Clear; 2) Feedback Is Immediate; 3) Skills Match Challenges; 4) Concentration Is Deep; 5) Problem Are Forgotten; 6) Control Is Possible; 7) Self-Consciousness Disappear; 8) The Sense of Time Is Altered; 9) The Experience Become Autotelic. Novak et al., [12] summed up first three conditions which considered to be the antecedent conditions to generate flow experience. In the subsequent empirical research, some scholars [14-16] proved that these three antecedent conditions have an important influence on learners' ability to get flow experience and achieve better learning performance. So, we're going to describe flow mainly from these three antecedent conditions.

- Goals Are Clear & Feedback Is Immediate

One of the things that people will feel happy about when they really get into something is that they know very clearly what they have to do from one moment to the next. Clear goals help to make learner's actions more involved in the task and increase the chance of the generation of flow experience. However, a clear goal is not enough, learners also need to know what they are going to do, whether they are doing the right thing, and whether there is a need to correct their practices and behavior. Consequently, teachers need to immediately feedback to learners of their learning condition. It's because of the clarity of goals and immediate feedback that the attention keeps getting carried and focused. If learners do not get feedback and do not know how well they are doing, then they might start getting distracted. Their mind has a chance to pay attention to other things because it doesn't have to monitor the information coming back [13].

- Skills Match Challenges

To achieve a better learning performance, learners need to be provided challenges that match their existing skills. Csikszentmihalyi said that if the degree of challenge is much higher than the level of skill [13], learners may feel a sense of strain, and the effect would be less than expected. Learners would likely generate a sense of anxiety, thereby reducing the immersion and engagement of learning and motivation to continue learning. And then they may begin to distract from other issues unrelated to this task. Conversely, if learners were provided a learning task that is lower than their skill level, they would finish it quickly with little think and little time and after a while they would feel bored, begin to distract and lose their desire to continue learning. Because a learner thought his/her skills was not being used, that there was no opportunity for him/her to express his/her skills. A research by Tuss [17] shows that only when the degree of challenge is equal to or slightly higher than the level of skill, learners' quality of subjective experience would be optimal and then generate flow experience, finish the task with enjoyment and deep concentration.

The three antecedent conditions for the appearance and generation of flow experience are to drive learners to be highly involved in the learning process, concentrate on the tasks and then learn more new knowledge and skills. In this process, learners' behaviors and consciousness are integrated, they only respond to the clear goals and definite feedback of the activity, and generate a sense of potential control through the manipulation of the environment. They concentrate deeply and devote themselves to what they are doing, generating an enjoyable learning experience while acquiring knowledge and skills. In this experience, learners are able to filter out external obstacles, disappear from self-consciousness, alter the sense of time and their experience become autotelic.

2.2 Smart Learning Environment（SLE）

Smart learning environment is also known as a learning environment with intelligent or educational technologies. For its definition and characteristics, different scholars from their own point of view put forward different ideas. Huang et al., [10] believes that SLE is a learning place or activity space that can perceive learning scenarios, identify learners' characteristics, provide appropriate learning resources and convenient interactive tools, automatically record the learning process and evaluate learning results, so as to promote learners ' effective learning. Huang combined the views of scholars [19-22] and the condition of using technology enhanced learning, concluded that SLE is mainly composed of learning resources, intelligent tools, learning community, teaching community, learning style and teaching method. Jelena Jovanović et al., [18] hold that SLE can be broadly defined as computer-based educational systems that rely on diverse Artificial Intelligence (AI) techniques to improve learners' learning experience, and help them reach their learning objectives.

The "Smart" in the Smart learning environment is mainly embodied in using intelligent technologies to support learners' learning and practice [23]. In SLE, teachers can provide learners with abundant learning resources through the network and various intelligent devices, record learners' learning conditions and behaviors data and then send to cloud. The intelligent technologies can facilitate teachers to design appropriate learning content and activities according to learners' data, and provide them with immediate guidance and feedback and make individualized learning possible. At the same time, learners can use the synchronous communication tools such as QQ, WeChat and Skype, and asynchronous communication tools such as Weibo, Facebook and virtual learning community to actively participate in learning activities. In addition, teachers can use augmented reality technology to create a real context, so that learners can involve themselves and enhance their learning motivation and interest. Now, we have various intelligent tools that teachers can choose according to learning content to promote learners' performance and enhance learning experience.

3 Framework of Learning Activity Design

3.1 Proposed Framework

Based on the above theories, this research proposes a framework of learning activity design by considering the flow experience in smart learning environment. As shown in Figure 1.

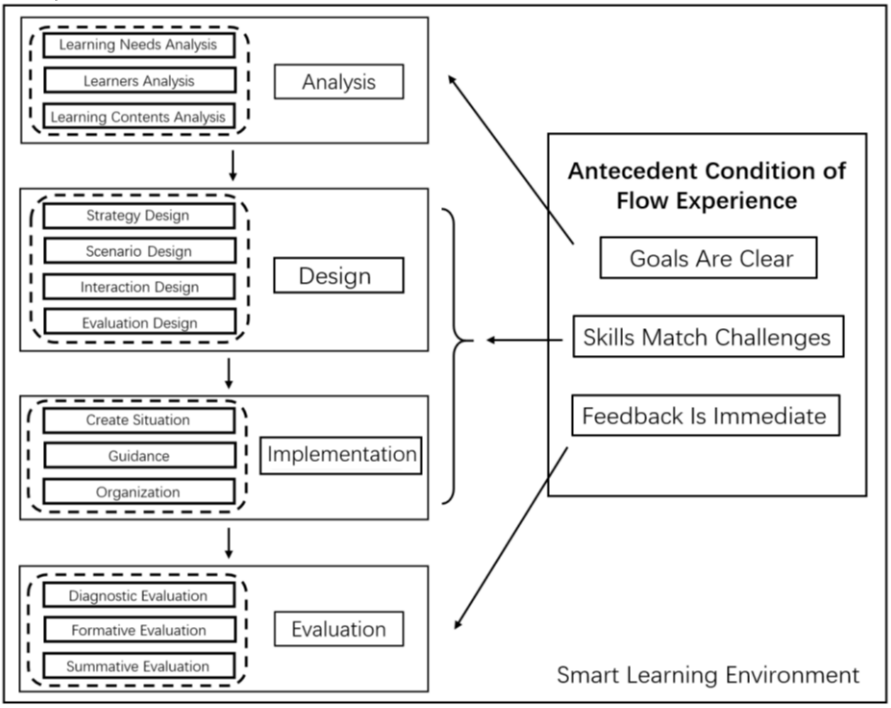

Fig. 1 Framework of Learning Activity Design

By combining the actual analysis with the flow experience, this framework restores the four steps that teachers should pay attention to in teaching, analysis, process design, implementation and evaluation. This study mainly illustrates the teaching process, which aims to achieve the optimization of teaching effect by analyzing and combing the interaction and activities between two major elements in the process of learning, as shown in Figure 2, and designing the new teaching mode under the perspective of flow experience. There will be a detailed explanation of Figure 2 In the next paragraph.

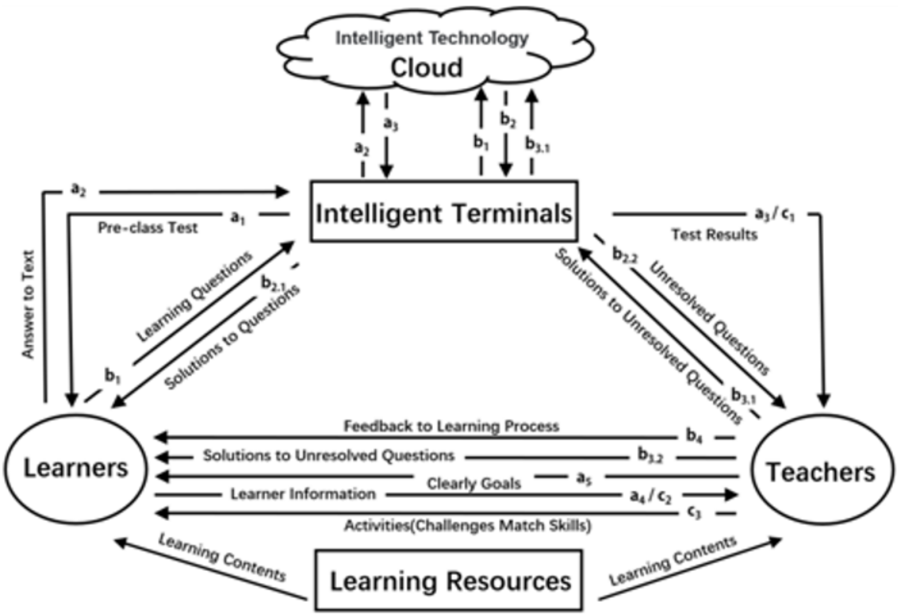

Figure 2 Learning Processes in Proposed Framework

3.2 Interpretation of the proposed framework

In order for learners to have a flow experience in SLE, there are generally three conditions, A Clear Goal, Immediate Feedback, and Skills Match Challenges. Through the actual teaching process of teachers, the four teaching steps to be carried out are combed out.

Analysis. The first step is three analyses, which include learning needs, learners and learning contents. The learning needs analysis is to analyze the knowledge the learners already have and the syllabus the learners will learn in order to reduce the gap between them. In the learner analysis, intelligent terminals would send a pre-class quiz (Figure 2, a_1) to learners when they start to learn a course in SLE. Once the learners finish the quiz and then submit their answers (a_2), which would be sent from terminal to cloud. (a_3). Subsequently, the test results would be analyzed and deliver to teachers via cloud-based technology. Based on the analyzed results (a_3) and the observed learners' behavior information in SLE (a_4) including learning interests, learning styles and learning willpower, the teacher will obtain a personalized report and characteristics about the learners. According to learner's personality characteristics, teachers could divide learners into different groups, so as to provide individualized teaching services for them. Final, teachers could combine the syllabus with textbook contents to analyze the difficult and important points of course in the learning contents analysis. Combining above three analyses with learners' personalized characteristics in SLE, teachers could formulate different learning goals for learners of different personality (a_5).

Design. Teachers would set a clear goal matching different learners after three analyses, then the design step becomes the next key point which mainly includes the design of strategy, scenario, interaction and evaluation. In the strategy design based on the learning contents analysis, learner's learning ability as well as other factors, learning contents would be divided into different levels in order to provide personalized teaching strategies. By the way, the level here needs to be divided carefully by teachers. Skills match challenges, which is the second condition of generating flow experience, is essential and indispensable point in learning activities design. It would directly determine whether the teaching strategies are appropriate, whether learning goals are suitable and whether learners are immersed and involved. Based on the pre-test results (a_3/c_1) and learners' information (a_4/c_2), teachers could design a series of learning activities that meet learners' ability on the basis of a balance in challenges and skills (c_3). In the scenario design, teachers need to combine the above designed learning strategy with learner's individual characteristics in order to design a scenario which is matched with specific learning contents. In this situation, every learner has his/her suitable role to engage the learning activity. Immediate feedback, which is the third condition of generating flow experience, is essential and indispensable for learners to interact with other participant in a timely and effective manner. In a process of learning, learners' questions could be transmitted through intelligent terminals to the Cloud (b_1). Then, intelligent technologies in cloud would summarize and find the answer immediately, and then feedback learners via the terminal (b_2). It may cause two branches for this case. First, if there have already existed answers for the question in the cloud, it would transmit the answers directly to the learner ($b_{2.1}$) through intelligent terminals to meet the request of feedback in the timeliest manner. Second, when it comes to a question that could not be solved by searching answer in the cloud, the cloud would send it to the teacher ($b_{2.2}$). After the teacher has solved the question, he/she would return the solutions and techniques of the question to learners ($b_{3.2}$) and storage it in the cloud ($b_{3.1}$) as well. At the end of the process design step, the evaluation should be designed, which will be illustrated in detail in the evaluation.

Implementation. Completed the analysis and design step, teachers could create interesting learning scenarios in SLE, such as a game. These scenarios would guide and organize learners to learn by integrating relevant information, and recording the teaching process if the learners have a new problem, then teachers can feedback to learners' questions or correct their misunderstandings immediately.

Evaluation. The evaluation step has a role that cannot be neglected. It can be divided into three parts according to time lapse: diagnostic evaluation, formative evaluation and summative evaluation. The results of diagnostic evaluation in this framework will be transmit to teachers to make learning goals, design teaching strategies and realize individualized teaching services. Formative evaluation will be carried out in the teaching process, teachers could find the learner's problems and then feedback them immediately. Summary evaluation could be a periodic summary of each class or each week, each month or the school year, etc. The purpose is to enhance learners' learning performance.

Based on the above four steps for learning progresses using flow experience in SLE, the design of learners' learning activities and teachers' teaching activities are having strong interactions and relationships. All of steps interact and influence each other to jointly improve learners' learning experience and enhance their performance.

4 An Example for this Framework

The following is an example of the learning activities for role-playing game in a mathematic course about addition and subtraction.

A teacher will give a math quiz to the learners by intelligent terminal for diagnostic evaluation while the learners start learn addition and subtraction in their learning environment. The purpose of this work is to identify learners' prior knowledge and cognitive status of learners. Meanwhile, it can also understand other individual learning characteristics of learners by observing learners and recording the results of one-to-one conversations. Then, the information will be sent to the Cloud, and then it will form a report of individual characteristics for learners. For one situation, according to the report, the teacher may know some of learners already have the ability to understand the number, know that which number is bigger or smaller, some could do simple addition operations, and some could do both addition and subtraction operations. According to the results of this difference ability, the learners could be divided into three groups. The teacher would formulate suitable learning objectives for different groups. For the first groups, learners do not perform addition and subtraction well, the main goal of learning is to perform simple addition operations. For the second group, learners who have learned to add operations better, learning goal for them is to more focus on the subtraction operations. For the third group, learners who could use both addition and subtraction operations, the learning goal is to provide some mixed and complex operations with addition and subtraction. Such different learning goals can meet the various levels of learners. At the same time, the clear goals can let the learners clearly know what learning achievement they need to achieve after the class.

Then, it is easy to create a game-like scenario which is similar to Sim City game. In this scenario, learners play different roles to learn addition and subtraction. There may have three types of roles that learners could choose: supermarket bosses, consumers and bank clerks. We assume that the supermarket bosses only need to sell the goods and make money without consuming process, which means the bosses only do the addition operation. Then, the learners who have to learn the addition operation will be assigned to this role. For the second role, we assume that the consumers have a certain wealth. They would consume money in the supermarket, so that the learners who have to learn subtraction will be assigned to this role. It means that the role of consumers is only to do the subtraction operation. For the role of bank clerks, the learners who will learn complex operations will be assigned for doing both of addition, subtraction and mixed operations. Obviously, it will attract the learners' interest by creating the game-based learning scenario, and matching different skills and challenges, which may help the learners to generate the flow experience in their learning processes.

The evaluation process can be based on the different roles of learners, such as the learners who play supermarket bosses can evaluate them by comparing the incomes. The learners who plays the consumer can check their own remaining money to see if there is any money are miss calculated because of the incorrected arithmetic in the game. The learners who act as bank clerks can be evaluated them by comparing the number of trades and the correction of calculations.

5 Conclusion

From the perspective of flow experience, this study considers the steps of learning activity in the smart learning environment and then propose a framework of learning activity design for flow experience. An example of teaching addition and subtraction in a mathematic course is designed to use this framework into a game-based learning scenario. For the future study, we will provide further evidences to prove this framework could really help the learners to gain a good flow experience as well as guide teachers to design their activities with flow experience in a smart learning environment. This study is just a theoretical framework, not a practice. We and follow-up researchers could conduct empirical research based on this framework to find more evidence to prove the significance of our research in learning activity.

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A Partner Robot for Decreasing Negative Concerns in Collaborative Reading

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Abstract. Collaborative reading in English is instructive for second language learners to improve their communication skills. However, it is not easy for Japanese learners to read English sentences in collaboration with a partner due to their embarrassment and uncomfortableness. In this work, we propose a partner robot for collaborative reading of English sentences. This paper demonstrates the partner robot system we have developed, and reports a case study with it. The results suggest that the robot system decreases learners' embarrassment and uncomfortableness, improves their engagement in and concentration on collaborative reading, and gives a sense of self-efficacy as to improving their English communication skills more than collaborative reading with human partner.

Keywords: collaborative reading, second language learning, partner robot

1 Introduction

Collaborative reading in English brings about communication. It is instructive for second language learners to improve their communication skills since it creates an interpersonal context. It also motivates them to learn English [1].

However, it is not easy for Japanese learners to read English sentences in collaboration with a partner [1,2] since collaborative reading causes the following negative concerns. Firstly, reading in the presence of the partner causes them considerable embarrassment. Secondly, some learners would feel reluctant in collaborative reading. Most Japanese often feel embarrassment in doing something in front of people and in exposing their poverty because the culture of shame is rooted in them [3]. Thirdly, the gap in English skills between the learners and the partner would also decrease their motivation for reading English sentences. These negative concerns would prevent them from improving their English communication skills.

English classes in Japanese primary and secondary education often involve collaborative reading practices, but lack interpersonal context indispensable for improving communication skills. Although reading aloud is emphasized in the practices, it is not conducted effectively. According to [4], there are 48 techniques in reading aloud. For example, there are techniques in reading aloud after listening to a model reading (*listen and repeat*), and in reading aloud while looking texts or

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reciting. Also, there are two purposes of collaborative reading, which are to understand pronounce of words and to read aloud quickly and accurately. Such various techniques should be used depending on learners' English proficiency, but the techniques used in the practices are so limited particularly to *listen and repeat* [4].

There are also educational systems using PC or tablet devices for improving English communication skills. But, interaction with virtual partner displayed on the interface could not provide authentic interpersonal context. Also, there is a method of online English conversation with human partner via PC, but Japanese learners feel sorry when they cannot listen to what the partner say or cannot speak English well [5]. It would be accordingly difficult for these systems to bring about English communication in an effective way. According to [6], willingness to communicate (WTC), establishment and maintenance of interpersonal context, and motivation are important for ESL (English as second language) learners. In addition, it suggests that self-efficacy and anxiety about communication with second language have a potent influence on WTC.

Therefore, promoting collaborative reading for improving English communication skills needs (1) to decrease negative concerns in collaborative reading to enhance WTC, (2) to read aloud in various techniques depending on learners' proficiency, and (3) to increase the authenticity of interpersonal context. Regarding (2), some adaptive support could be applied [7], but how to resolve (1) and (3) is technically an important issue.

In this work, we propose a partner robot for promoting collaborative reading. The robot is expected to help learners avoid their embarrassment and reluctance caused by reading in the presence of other learners. It is also expected to resolve the gap in English skills between the learners and their partner robot since the robot could read English at the same level as the learners. Moreover, the robot could increase the authenticity of interpersonal context since it could provide more embodiment of partner than PC-based or tablet-based learning environments. These are the main reasons why the robot is suitable as partner for collaborative reading.

Based on the above-mentioned viewpoints, we have developed a partner robot system, which reads English sentences in collaboration with learners to promote collaborative reading. In this paper, we describe the system and report a case study, in which we compared collaborative reading with the system and collaborative reading with human partner. The results suggest that the robot system significantly decreases learners' embarrassment and uncomfortableness, and improves their engagement in collaborative reading.

2 Robot as Partner

2.1 Roles

There are three main reasons to use robot for collaborative reading. The first one is that robot could resolve negative concerns in collaborative reading. The negative concerns involve the embarrassment caused by reading in the presence of other people, and the reluctance felt in interpersonal context. As [8] reported, even people who do not communicate with anyone could actively communicate with robot, and people who are depressed could consult with robot. In other words, robot could reduce their sense of psychological reluctance caused in interpersonal context, and promote communication with people. Collaborative reading with robot is expected to be more active than the one with human partner.

In addition, one of the negative concerns is the gap in English skills between learners and the partner. This would decrease their motivation to read English sentences. In case the gap is large, learners with higher skills would often feel that collaborative reading does not contribute to learning. Learners with lower skills would also feel sorry that it is boring for the partner [1]. In case of collaborative reading with robot, on the other hand, it is possible to bridge the gap in English skills by adjusting its skills in reading. Collaborative reading could be accordingly done more effectively. In addition, learners could repeatedly practice reading and hearing the sentences without the robot's conveniences.

The second reason is that robot could increase learner's concentration, and enhance learning effects. [9] suggests that a robot for teaching English could obtain more concentration from learners to produce more learning effects than existing e-Learning system, textbooks, and audio tapes. [10] also suggests that a robot allows learners to change their own way of learning when it changes the way of learning. In other words, the robot could promote "learning by observing."

Although correct pronunciation and rhythm in collaborative reading is important, in addition, it is not so easy for Japanese teachers in schools to appropriately pronounce and check the ones performed by learners. However, robot including voice synthesis and recognition unit such as "VoiceText" and "VoCon™Hybrid" [11,12] allows learners to learn the correct pronunciation and rhythm from the pronunciation performed by the robot and to confirm the correctness of their reading depending on whether the robot can correctly recognize their reading.

The third reason is to retain the authenticity of interpersonal context, which gives learners a lively sense of communication. In learning second language, a sense of communication is very important. However, communication creates an interpersonal context, in which negative concerns as described above are caused. Such concerns would prevent learners from improving their communication skills. On the other hand, the robot could retain the sense of communication in addition to decreasing negative concerns in the interpersonal context. [13] suggests that communication

Table 1. Reading Techniques and Purposes

easier	Level	Purpose	Technique
	beginner	To become able to read word by word precisely	Single word reading
		To clarify how to read words of a sentence	Listen and repeat
		To make learners read actively and joyfully	Reading together
	intermediate	To become able to read at own pace in the time limit	Time limit reading
		To smooth movement of jaw, lips and tongue, and become able to read quickly	Quick reading
		To make learners' reading understandable with precise pronunciation and rhythm as possible	Precise reading
		To become able to understand the meaning of sentence phrase by phrase or paragraph by paragraph	Slash reading
		To attentively listen to what the partner reads, and then read according to it	Taking turn on reading sentence by sentence
more difficult		To be able to understand the meaning of sentences through role-playing	Role reading

robots tend to be anthropomorphized as *human*. Therefore, the partner robot proposed in this work would induce learners to feel that it is like *human*.

2.2 Collaborative Reading Techniques

Following [3], we divide reading skill into three levels: beginner, intermediate, and advanced. The beginner level involves basic reading for conversion from letters to sounds. The intermediate level has two types of reading, which are reading for accelerating speed from letters to sounds, and reading for understanding the meaning of sentences. The advanced level involves reading for expressing emotions and perceptions. In this work, we consider the beginner and intermediate levels, which are supposed to be important in learning English in primary and secondary education.

Table 1 shows the collaborative reading techniques and purposes in each reading level, which we use in this work. The robot basically conducts collaborative reading session by session. Each session consists of several sentences. First, the robot starts collaborative reading with learners by means of a technique for the beginners. If the robot detects that their reading is at the beginner level, it selects a technique from the ones for beginners in Table 1. If the robot detects that their reading is not at the beginner level, it selects a more difficult technique from the ones for intermediate learners in Table 1. In particular, it selects an interactive reading technique such as role reading when they stably have accurate and speedy reading. It then conducts collaborative reading with the selected technique in the next session.

3 Partner Robot System

3.1 Framework

Fig. 1 shows the framework of collaborative reading with the partner robot system. In this work, RoBoHoN [14] produced by SHARP is used as partner robot. RoBoHoN is a communication robot, which could make rich communication with

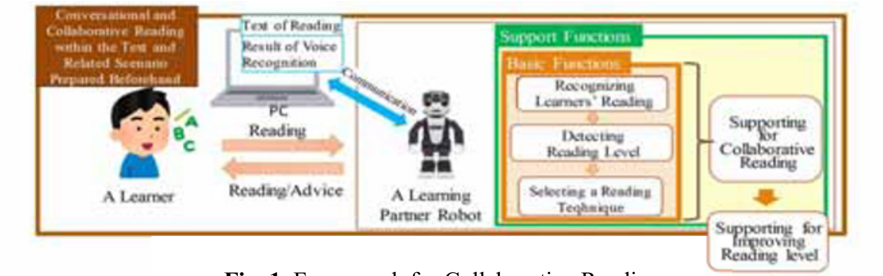


Fig. 1. Framework for Collaborative Reading

human by means of its gestures. It is also suitable as a partner robot because it is portable and could be used anywhere.

Collaborative reading is conducted with 9 techniques that are shown in Table 1. The robot intends to increase the difficulty of collaborative reading techniques according to leaners' reading levels. As shown in Fig. 1, a reading text is displayed on a PC, which has communication with the robot. The learners perform collaborative reading with the robot while watching it. The robot can conduct conversation and collaborative reading within scenario prepared beforehand. In other words, the robot cannot conduct flexible conversation and question-answering like human teachers, but interaction with the robot is possible in the limited context.

In collaborative reading with learners, the robot recognizes their reading with VoCon™Hybrid as voice recognition unit, and displays the recognized results on the PC. The robot then gives feedback including advices for their reading and pointing out their mistakes.

The robot next detects learners' reading level, and selects a reading technique for the next session according to the detected level. If their reading is improved, the robot compliments them. If they don't read well, the robot induces the learners to imitate a model reading.

3.2 Functions

As shown in Fig. 1, the system has three basic functions. First, the robot recognizes learners' reading to display the results on the PC. If there are misread words, they are highlighted in red. Secondly, the robot detects learners' reading level with voice recognition. The reading level is detected as word accuracy and reading speed [15]. Word accuracy represents the one of word pronunciation. In this system, it is calculated as the ratio of the number of words mistaken, which the system detects by means of voice-recognition. If the ratio is less than 20%, 20% to 50%, or more than 50%, the word accuracy is detected as high, medium, or low. The reading level is also detected as intermediate when the accuracy is detected as high. It is also detected as beginner when the accuracy is detected as middle or low. As for reading speed, it is represented by WPM (Words Per Minute), which means the number of words read per minute. Although it is important for learners to read more accurately, speedy reading is required as English skills. The robot gives feedback compliment when learners' WPM detected goes beyond a threshold. However, it prompts the learners to read slowly when their word accuracy detected is low. Such reading level detection allows learners to practice collaborative reading with constant awareness of word accuracy and reading speed. Thirdly, the system selects a reading technique suitable for learners' reading level detected.

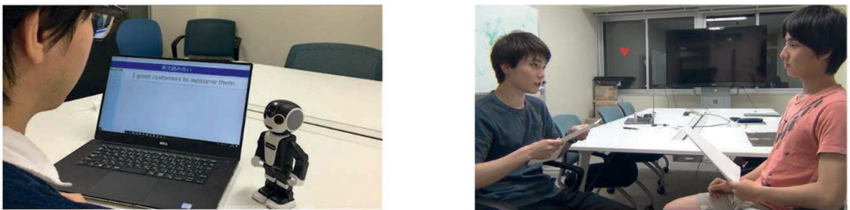
4 Case Study

4.1 Preparation and Procedure

We had a case study whose purpose was to ascertain whether the robot could resolve negative concerns in collaborative reading. The participants were 16 graduate and undergraduate students in informatics and engineering. We set two conditions: collaborative reading with the partner robot (R condition), and collaborative reading with human (H condition). As within-subject design, each participant conducted collaborative reading twice under these two conditions. We divided the participants into two groups called group R-H and group H-R in order to control the order effects. We randomly assigned 8 participants to each group. Group R-H first conducted collaborative reading under R condition, and then conducted collaborative reading under H condition. Group H-R conducted collaborative reading in the reversed order.

In collaborative reading, the participants were required to read a conversational script, which consisted of ten sentences. They used two reading techniques, which were the one for taking turn on reading sentence by sentence and the one for role reading. They were also required to read a script five times with each technique. They had each script in each condition so that they could not become accustomed to reading the sentences.

Fig. 2 (a) shows how a participant conducted collaborative reading with the robot. The robot detected learners' reading level for every sentence. When their level was detected as beginner even in one sentence, the robot gave feedback, which induced them to re-read the sentence as practice with the technique of *listen and repeat*. If they finished the practice, the robot gave feedback, which induced them to return to



(a) The Robot condition (b) A Human condition

Fig. 2. Collaborative Reading

collaborative reading. Fig. 3 shows an example of interaction between the robot and a participant during collaborative reading with the technique of role reading.

Fig. 2 (b) shows how a participant conducted collaborative reading with a human partner. In this study, two participants conducted it each other. In every sentence, one participant was allowed to freely point out about the partner's reading. All the participants were given explanations about the following two points. One was that the aim of collaborative reading was to improve their English communication skills. The other was that they needed to look at the partner's face and eyes as much as possible when reading because communication is usually conducted while looking at the partner's face and eyes.

Each participant was required to answer the questionnaire (a) under each condition after collaborative reading. The questionnaire (a) included *common questions* and *individual questions* for each condition. *Common questions* consisted of 14 questions with 5-point Likert-scale, which had four purposes. The first one was to investigate how much the participants engaged in collaborative reading with the partner (11 questions derived from [16]). The second one was to investigate how much they felt embarrassment and uncomfortableness (1 question). The third one was to investigate how much they felt the gap in English skills between them and the partner (1 question). The fourth one was to investigate how much they felt their sense of self-efficacy as to improving their English communication skills (1 question). In addition, *individual question* in R condition consisted of 1 question with 5-point Likert-scale for investigating the impression of the robot. On the other hand, *individual questions* in H condition consisted of 2 questions with 5-point Likert-scale for investigating how much the participants felt good friendship with the partner and how much influence it had on readiness of collaborative reading.

After the questionnaire (a), the participants were furthermore required to answer the questionnaire (b) for comparing R condition and H condition. The questionnaire (b) consisted of the following 3 questions, each of which provided two choices the robot or human partner:

RoBoHoN: I will read the part of Mr. A
RoBoHoN: Please, read the part of Mr. B. Well, let's get started.
==Role reading starts==
RoBoHoN: A: Where did you go on Career Day?
Participant: B: I went to an Italian restaurant. I want to be a chef.
RoBoHoN: A: Wow, how was it?
Participant: B: It was interesting but I got tired.
Participant: B: I tried to .... (The participant cannot read it well, and chokes on their words.)
(The robot detects his/her reading level as beginner.)
RoBoHoN: A: I see. I went to a newspaper company. I want to be a journalist.
Participant: Sounds interesting.
==Role reading ends==
RoBoHoN: It's a nice but you should practice some sentences.
RoBoHoN: Let's practice this sentence. (the sentence to practice is displayed on PC.)
RoBoHoN: Please imitate my reading aloud.
==Listen and repeat starts==
RoBoHoN: I tried to learn the whole menu, but I couldn't.
Participant: I tried to learn the whole menu, but I couldn't.
RoBoHoN: Very good.
RoBoHoN: Then, let's read again making use of this practice.
==Listen and repeat ends, and return to role reading==

Fig. 3. Example of the Interaction between the Robot and a Participant during Collaborative Reading by Method of Role Reading

- Which did you feel easier to perform collaborative reading with?
- Which did you feel familiar with as the partner of collaborative reading?
- Which promoted your concentration on collaborative reading?

In order to evaluate the effectiveness of the system, we analyzed the results of the questionnaire (a) and (b).

4.2 Results

Fig. 4 shows the average scores from the results of questionnaire (a). Regarding engagement, the score was calculated by summing the participants' answers to all 11 questions. From the one-sided t-test, there were significant differences between the average scores in R condition and H condition as for embarrassment/uncomfortableness, self-efficacy and gap (embarrassment/uncomfortableness: $t(15)=-4.74$, $p<.01$, self-efficacy: $t(15)=2.95$, $p<.01$, gap: $t(15)=3.96$, $p<.01$), and there was a tendency of significant difference between the average scores in R condition and H condition as for engagement ($t(15)=1.35$, $p<.10$). These suggest that the robot could decrease their embarrassment and uncomfortableness, and improve their engagement and self-efficacy.

As for self-efficacy, the result suggests that feedback from the robot works effectively. In H condition, there was little advice from/to the partner. In R condition, on the other hand, the robot pointed out the participants' reading, and performed model reading. Therefore, it seems that they felt that they could improve their English communication skills.

As for gap in English skills, on the other hand, the participants felt the robot making the great gap in English skills between the participants and it. The reason for this is that the robot does not have any function for bridging the gap in English communication skills. Although the gap in English skills causes negative concerns, it does not apply to this case study since the results of questionnaire (a) suggest decrease in embarrassment and uncomfortableness.

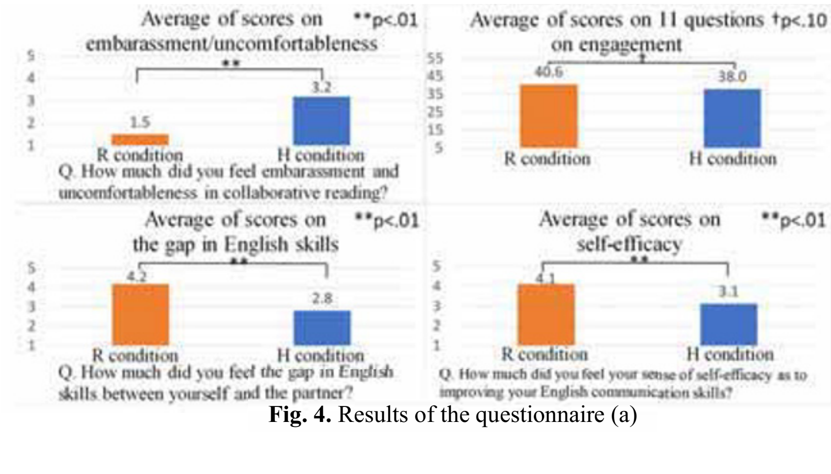


Fig. 4. Results of the questionnaire (a)

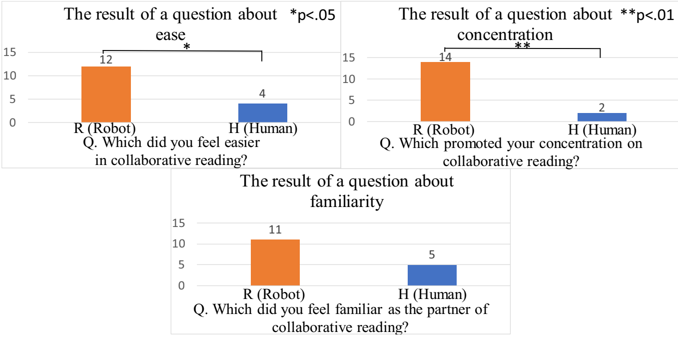


Fig. 5. Results of the questionnaire (b)

Fig. 5 shows the results of questionnaire (b). The one-sided accurate binomial test was conducted on these results. As for concentration and ease, there were significant differences between the numbers of participants who selected the robot and the human partner (concentration: $p=0.0021$, $p<.01$, ease: $p=0.0384$, $p<.05$). From the results, it is considered that the participants' concentration and ease of collaborative reading were improved. We think the main reason is that the robot decreased embarrassment and uncomfortableness in collaborative reading.

As for familiarity, there was no significant difference. About half of pairs in H condition had good friendship each other, but the robot gave more participants a familiar impression. This suggests that the robot could perform collaborative reading as naturally as a human partner. On the other hand, there were some participants who felt that impression of the robot became negative because its voice recognition unit implemented was too sensitive for Japanese learners to read, and because interaction with it was so limited.

These results shown above suggest that the partner robot system could create interpersonal context and enhance learners' WTC, which are important factors in ESL. This also suggests that the system could work effectively for ESL learners. In other words, the partner robot system could provide a new learning environment for ESL.

5 Conclusion

In this work, we have proposed and developed the partner robot system for promoting collaborative reading. From the results of the case study, the robot could decrease learners' embarrassment and uncomfortableness, and improve their engagement in and concentration on collaborative reading. In addition, collaborative reading with the robot gives a sense of self-efficacy as to improving their English communication skills more than collaborative reading with human partner.

Furthermore, there are few existing ESL learning support systems that take the authenticity of interpersonal context into consideration. It contributes to reducing negative concerns, and providing a more effective learning environment.

In future, we need to refine the partner robot system so that it can particularly bridge the gap in English communication skills between learners and the robot. In addition, it is necessary to resolve limited interaction with the robot not to let learners get bored. It is also necessary to alleviate the sensitivity of voice recognition unit not to prevent them from keeping their motivation.

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An Architecture for Mobile-based Assessment Systems in Smart Learning Environments

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Abstract. Assessment is a fundamental part of the learning process and therefore a key aspect in smart learning environments. Despite the existence of some architectures and frameworks for supporting assessment with mobile technologies, there is still a need of more research on how these systems should be designed for smart learning environments. In this paper we extend previous research on mobile-based assessment to introduce an architecture to inform the design and development of mobile-based assessment systems for smart learning environments to foster smart learning. The architecture consists of a client side (mobile app) and a server side web application. Preliminary results obtained from an evaluation study shows high levels of students' acceptance and intrinsic motivation after using a mobile-based assessment application that implements the architecture.

Keywords: mobile-based assessment · smart learning environment · Mobile learning · Software architecture.

1 Introduction

Assessment is a fundamental part of the learning process [1] [2] that can be supported by mobile technologies [3]. Mobile technologies are useful for managing assessment processes in terms of distributing exams, collecting responses, providing automated revisions, feedback and consolidating information [4]. In that regard, according to the UNESCO [4], mobile technologies (and in particular mobile-based assessment systems) can improve assessment processes by providing immediate information about students' progress as well as instant feedback. These features are useful for helping students to advance in their learning process and provide teachers with information to identify if students are making progress or not so that teachers can make the necessary changes in teaching. Given the importance of assessment in learning processes, research on mobile-based assessment systems is important for improving learning processes when mobile devices are used in the

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classroom. Consequently, there is a need of efficient processes and methods for improving assessment processes in the context of smart learning environments.

In this paper, we briefly introduce an architecture to inform the design and development of mobile-based assessment systems for smart learning environments. Moreover, we describe preliminary results of an evaluation study of a mobile-based assessment application for English language learning developed according to the architecture. The rest of this paper is organized as follows: section 2 describes the related work and section 3 presents the foundations of the architecture. Next, sections 4 and 5 describe the client side and server side of the architecture respectively. Section 6 describes an example of implementing the architecture in the K-English application and section 7 describes the preliminary results of the evaluation study. Finally, section 8 presents some conclusions and future work.

2 Related Work

Previous research on mobile-based assessment systems have resulted in the definition of some architectures and frameworks to inform the design of such systems. For instance, Abdulwahed, Nagy and Blanchard [5] introduce an architecture for providing automatic formative assessment through feedback using SMS messages. El-Sofany and El-Seoud [6], developed a web-based assessment system with a mobile version based on semantic web. Ontologies are used for providing adaptive learning and contextual knowledge for the learning objects. Huang, Lin and Cheng [7] developed an adaptive testing system based on particle swarm optimization and Item Response Theory for providing formative, summative and self-assessment tests. Another approach was adopted by Riad and El-Ghareeb [8] who introduce a service oriented architecture including software agents and recommendations for mobile assessment learning management systems. On the other hand, the architecture introduced by Nguyen and Pham [9] is based on context-awareness and personalization to prepare students for the TOEFL exam. However, each one of these architectures and approaches focused on important but very specific independent aspects of the assessment process such as feedback, adaptive assessment, self-assessment, delivery, multimedia among others. These aspects are part of smart learning environments but a broader perspective that integrates these aspects with pedagogical components to create “smart learning” [10] is still needed. To address this research gap, in this paper we extend previous research in mobile-based assessment and we introduce an architecture for mobile-based assessment for smart learning environments with a broader perspective for fostering smart learning. In that regard, we contribute to the research on the adoption of personalization and context-aware technologies in mobile-based assessment systems [11].

3 Foundations of the architecture for mobile-based assessment systems for smart learning

The architecture is aimed at guiding researchers, practitioners and other stakeholders in the development of mobile-based assessment systems for smart learning environments. The architecture consists of two main sections: 1) Mobile-based assessment (client side) and 2) the Web application (server side).

Fig 1. Architecture for mobile-based assessment systems in smart learning environments.

Figure 1 shows the architecture. Our architecture is based on the Triple-A model introduced by Wang et. al. [12] and includes some aspects of smart learning environments. The Triple-A model consists of the following components:

- Assembling: Component dedicated to managing (designing and implementing) the items for the tests and scheduling the tests. In our architecture this component is equivalent to the web application that is on the server side (see section 5).
- Administering: Component that is in charge of applying the tests to students and gather information from this process such as answers and scores. In our architecture this component is equivalent to the mobile application (client side of our architecture – see section 4).
- Appraising: Component that process the data collected from the mobile-application to show results and information to teachers. In our architecture

this component is also on the server side (see section 5) to generate the learning analytics and reports that can be useful for teachers.

Section 4 describes the Mobile-based assessment component (client side) and Section 5 describes the Web application (server side).

4 Mobile-based assessment (client side)

This section of the architecture represents the mobile-based assessment component that is used by the students during the assessment process. This section of the architecture implements the administering component of the Triple-A architecture and is divided into the following modules: interface and Support Services (see section 4.1), Pedagogical Components (see section 4.2), Assessment (see section 4.3), Learning Analytics (see section 4.4), Recommender Module (see section 4.5), Data Access Services (see section 4.6).

4.1 Interface and Support Services

This component of the architecture consists of the following three components: The user interface manager, Authentication and Notifications receiver.

- **User Interface Manager:** this component manages the user interface and interaction with the users. It includes the mechanisms for providing support for different resolutions and screen sizes for the different mobile phones.
- **Authentication:** Since the mobile application can be installed by many students, it is important to identify which instance of the application is being used by each student so as to have a personalized report for each student. To do that, each student receives a unique numeric code (Personal Identification Number - PIN) that is generated by the teacher using the web application. This code can only be used once and is used to unlock the mobile application in the students' smartphone so that the instance of the application can be associated to only one student. This unique code identifies students in the system and is used to store all the information about the students' progress and to provide personalized services. Students only need to insert the code once they install the application.
- **Notifications Receiver:** this component works as a service in the mobile application and is designed to receive push notifications that are sent by the web application. The purpose of these notifications is to provide timely feedback and recommendations to students on how well they are doing in the application or what they need to improve or practice more. This component

was defined according to the findings of some authors with respect to the positive effect of feedback on students' learning outcomes [13] [14].

4.2 Pedagogical Support

This module consists of the following components: scaffolding and feedback. These two components are described as follows:

- **Scaffolding:** Scaffolding is defined by Shepard [15] as the "support that teachers provide to the learner during problem-solving – in the form of reminders, hints, and encouragement – to ensure successful completion of a task". Scaffolding, has a positive effect on students' learning outcomes in e-learning applications [16]. In our architecture, the scaffolding component provides hints and clues to help students to solve the items of a test in the context of a formative assessment. The provision of scaffolding is quite relevant for helping students to achieve mastery in the topic. In the context of smart learning environments, the scaffolding component takes advantage of the recommender module (see section 4.5) to provide a personalized scaffolding according to the students' level of competence in the topic or according to the students learning style. Some examples of scaffolding mechanisms for a mobile-based assessment application can be: to include a mechanism that removes one or two incorrect options from a multiple-choice question (50/50) or to provide hints or clues to students in order to help them to answer an item. These mechanisms are intended to help students to gain expertise in the learning topic. When students reach certain level of mastery the scaffolding mechanisms could be automatically removed.

- **Feedback:** Feedback is defined "as information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" [13]. Feedback is considered to be one of the most important factors that positively influence students' learning outcomes [13] [14]. Based on the importance of feedback in the literature, the feedback component was included in the architecture proposed. The main purpose of the feedback component is to provide positive and attributional feedback so that students achieve mastery in the topic. This component works together with the recommender module in order to provide personalized feedback so that the feedback can be adjusted to the students' level of competence or students' preferences and needs. Feedback can be provided for each answer to an item. This might include providing feedback when the answer to an item is wrong and explaining why that answer was wrong or positive reinforcement when the answer to the item is correct. Machine learning techniques can be used to provide some form of automatic and personalized feedback.

4.3 Assessment

This module of the architecture contains all the functionalities to deploy the tests and items that students need to solve in the mobile-based assessment application.

- **Questions Manager Engine:** this component encapsulates all the mechanisms for displaying different types of questions (items) to students. This component needs to be able to display different types of items such as multiple-choice questions, true/false, open-ended questions, fill in the blanks, etc., depending on the learning topic and the teacher needs. This component needs to be developed with mechanisms to check the correct answer to an item and to associate the appropriate scaffolding and feedback mechanisms to each item. We suggest that the mobile-based assessment application can be developed with a mechanism that retrieves the items from a server to reduce the resources consumption. The question manager engine can take advantage of personalization and adaptive mechanisms to display the items according to the students' levels of competence, preferences, needs, interests or contexts.

4.4 Learning Analytics

This module of the architecture consists of components that gather information about the students' use of the application with the aim of showing information about their progress in the assessment process. Moreover, this component sends information about the student use of the application to a server in order to show visualizations that teachers can use to make decisions on the assessment process (see section 5). The learning analytics module consists of two components: the learning analytics (students' view and the Monitoring Module that are described as follows:

- **Learning Analytics (Students' View):** this component of the architecture shows some visualizations and statistics to students so that they can be aware of the progress they are doing with the mobile-assessment application. The definition of this component is in line with the recommendations of the Universal Design for Learning framework [17] to reduce barriers in the learning process. These visualizations might show how is the student's progress in relation to the rest of their peers. The visualizations could be processed by the server (web application – See section 5) and sent to the mobile device.
- **Monitoring Module:** this component monitors students' activity using the mobile-based assessment application. Some of the actions that can be gathered by the monitoring module are: the use of the scaffolding mechanisms, the amount of time that each student spent answering an item in

the system, the answers provided by students, the context in which students are using the application among other aspects that can provide information to the system in order to feed the visualizations for the learning analytics module or to provide information to the recommender module to personalize different aspects in the application (See section 4.5).

4.5 Recommender Module

The recommender module provides all the services of personalization and adaptive processes as one of the core aspects of a smart learning environment [10]. In that regard, the architecture for a mobile-based assessment application should include a recommender module that provides all the services needed to personalize the interface, content, scaffolding or other services according to the students' needs, preferences or interests. This module includes one suggested component:

- **Local Recommender:** this component is in charge of providing all the mechanisms of personalization and adaptation based on the information provided by the other components of the architecture, in particular, the local recommender works with information gathered by the Monitoring Module (see section 4.4). Semantic web technologies can be used to create a model of the learning domain and a model of the interaction of students to provide recommendations. Moreover, some models based on the Item Response Theory can be used to provide recommendations on the items that students need to practice more according to their performance. In addition, classification methods and convolutional neural networks (CNN) can be used to provide the recommendations. If these processes demand too much computing resources (memory, processing, etc.), the recommendations can be generated by the server side of the architecture (see section 5) and can be deployed by the local recommender component. Some examples on how the recommender module provides services for other components of the architecture are:
    - It might personalize the scaffolding, feedback mechanisms and the difficulty of items according to the students' needs or according to the students' level of competence in the topic.
    - It might adapt the recommendations to students according to their progress in the assessment process.

4.6 Data Access Services

This module of the architecture provides services for the local storage of information that the application needs to work correctly. In this module there is one component: Mobile Local Data Storage Service**.** This component provides a service for storing data in the mobile device. For instance, the application could store information about the student who is using the application or how frequently students use the application in the mobile device and synchronize this information to the server on a regular basis. This mechanism allows the application to send information to the server from time to time to avoid bandwidth saturation.

5 Web Application (server side)

The server side of the architecture consists of a web application that is located in a server. This part of our architecture extends the Assembling and Appraising components of the Triple-A model [12]. The web application provides different functionalities such as: creating the question (items) bank, creating the PIN code for students so that they can use the application, processing the data sent by the mobile application to show visualizations (learning analytics) to teachers and run the algorithms for providing the services of personalization.

6 Implementing the architecture (K-English application)

K-English is a mobile-based assessment application that implements the architecture introduced in this paper. The main purpose of K-English is that students can practice six of the types of questions (items) from the Cambridge KET (Key English Test) exam. These six types of items allow students to practice reading comprehension, listening and grammar (use of English). Figure 2a shows the main menu of the application where students can choose one of the six types of items for practicing.

Fig 2. Screenshots of the K-English mobile-based assessment application.

Figure 2b shows one of those types of items and the two scaffolding mechanisms developed for K-English: the clue and the 50/50 option. Currently the application has 305 items for all six types of items. Figure 2c shows a ranking in which students can see how they are doing with respect to their peers. The students' names have been removed to protect their identity. On the server side, a web application was developed. This application can be used to create the items bank, manage users and collect information about the student use of the application.

7 Preliminary Evaluation Study

The K-English application was tested with 100 university English language students (30% male and 70% female) from A1 and A2 levels from the Common European Framework of Reference for Languages (CEFRL). The age range of the participants was between 15 to 26 years old. Students used the application for a period of four weeks and answered an adapted version of the Mobile-based Assessment Acceptance Model [18]. Overall, we found promising results that show high levels of students' acceptance of the system. The mean values (in a scale from 1 to 5 where 5 is the maximum value) and standard deviation for each one of the evaluated dimensions of acceptance were: Feedback (M=3.6; SD=0.74), Behavioral Intention to Use (M=3.8; SD=0.77), User Interface (M=3.8; SD=0.72), Perceived Usefulness (M=3.9; SD=0.59) and Perceived ease of use (M=4.2; SD=0.74). We also evaluated two dimensions of student intrinsic motivation such as pressure/tension (M=2.8; SD=0.76) and importance (M=3.8; SD=0.54). As for the data collected by the monitoring module, the web application collected more than 12000 answers to the items. The scaffolding mechanisms (hint and the 50/50) were used 2625 and 2038 times respectively and the total amount of time that students spent answering all of the items was 84 hours. In general, these results suggest that students were engaged with the use of the application and it shows that students are using the scaffolding mechanism as a support for practicing in the application.

8 Conclusions

In this paper we introduced an architecture for the design and development of mobile-based assessment systems for smart learning environments. From a preliminary study conducted with the application, it shows that students engaged with the use of the application and the acceptance was high. We also concluded that the application allowed us to collect a large amount of data about the use of the application. This data is a valuable source of information that can be used to train algorithms for providing a personalized learning experience in mobile-based assessment systems. For future work, we are planning to compare students' learning performance with a control group of the same English levels to determine if is there any significant difference between the use of the application for practicing and the use of traditional learning materials.

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Analysis of Key Features in Conclusions of Student Reports

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Abstract. This work seeks to help students in improving their first research reports, based on natural language processing techniques. We present a Conclusion model that includes three schemes: Goal Connectedness, Judgment and Speculation. These subsystems try to account for the main expected features in conclusions, specifically the Connectedness with the general objective of the research, the evidence of value Judgments, and the presence of Future work as a result of the student reflection after the inquiry. The article details the schemes, a validation of the approach in an annotated corpus, and a pilot test with undergraduate students. Results of a prior validation indicate that student writings indeed adhere to such features, especially at graduate level. Statistical results of the pilot test showed that undergraduate students in an experimental group achieved improved conclusion content when compared with the control group.

Keywords: natural language processing · automated text evaluation · conclusion formulation · goal connectedness · reports assessment.

1 Introduction

A student report is a document describing the student's research and main findings on a topic. Often such report is further developed into a larger student thesis. Such document requires usually the guidance of an advisor. One study focused on the perceptions of students concerning difficulties when writing the discussion section of reports [1]. The study used in-depth interviews with supervisors and students (including L2) and found that pupils mentioned the uncertainty about what content to include and how discussion sections should be organized. This was surprising, considering the time and feedback that students received from supervisors.

In this paper, we focus on evaluating the conclusion section of student reports and perform a pilot test with undergraduate students. These are part of a larger project that aims to help students to evaluate their early drafts and facilitate the

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review process for the academic advisor. Besides, the review time can be reduced improving the quality of feedback provided by the instructor, through allowing the reviewer focusing on the conclusions content [5].

In a conclusion section, a discussion of the results is expected, and students are required to reflect on the whole research work. A good conclusion section should include: an analysis of compliance with the research objectives, a global response to the problem statement, a contrast between the results and the theoretical framework, areas for further research, and an acceptance or rejection of the established hypothesis [2]. A pattern that summarizes what is expected in a conclusion section is provided by the Teaching and Learning Centre at University of New England, Australia (UNE). The pattern goes from the specific to the general, and begins with a reformulation of the problem, followed by key findings, and ending with recommendations and future work. The guide pattern is similar to the conclusion of a scientific article, but more extensive.

In the conclusion pattern, the conclusion starts by pointing to the problem solved. In the five-paragraph essay paradigm [3], the introduction and conclusion share the main topic, namely, the subject matter of the essay. The approach is like the conclusions section, as the conclusion should be related to the general objective (considering methodological guides), in its first paragraph. In the intermediate paragraphs, the student must express his thoughts and opinions, avoiding a list of results. The Online Writing Lab at Purdue University provides an outline for writing conclusion sections, emphasizing that the conclusion must contain well-argued viewpoints and avoid inclusion of additional items that are not contained within the thesis [4]. Future work and recommendations included in the conclusion evidence that the student has gone beyond solving of the immediate problem and can identify possible expansion and implications of the work.

Based on the previous pattern and mentioned desirable features, we aim to use an automatic analysis of conclusions intended to obtain a first diagnostic of frequent problems in student's conclusion writings. For this purpose, we formulate this analysis in terms of three main subcomponents (schemes) that identify the following features of conclusions: *Goal Connectedness, Judgment and Speculation.* Due to the complexity of the task, this work only focuses on the conclusions section, besides of being a key section in a thesis or project.

We propose a system with a central Conclusion Model, integrating the three schemes and for this, we take advantage of a corpus to acquire the reference knowledge, to obtain the best features and set score thresholds. After evaluation of a conclusion supplied for analysis, our system will send the result to the student, with the goal of showing him the diagnosed level reached by the conclusion. The student will be able then to improve his conclusion based on the diagnosis, before submission to the advisor.

We report the use of the three features to assess a corpus tagged by annotators, to validate them, once they have been implemented in a computational tool. In addition, we present the results of a pilot test with undergraduate students of engineering, revealing a correlation between Goal Connectedness and Judgment characteristics. Such outcome provides evidence that students are indeed connecting their value judgments with the general objective.

2 Related Work

Automated Writing Evaluation (AWE) of student texts, also called Automated Essay Scoring (AES), refers to the process of evaluating and scoring written text using a computer system. Such a system builds a scoring model by extracting linguistic features (lexical, syntactic or semantic) on a specific corpus that has been annotated by humans. For this task, the researchers have been using artificial intelligence techniques such as natural language processing (NLP) and machine learning. The system can be used to directly assign a score or a quality level to a student text [6]. The use of AWE systems offers students ways to improve their writing in an automated manner, and helps to reduce review time required by academic advisors and is a complementary tool to their work.

Currently, the advances in AWE systems include the use of natural language processing technologies to perform the evaluation of texts and provide feedback to students. In this context, the system Writing Pal (WPal) offers strategy instruction and game-based practice in the writing process for developing writers. WPal assesses essay quality using a combination of computational linguistics and statistical modelling. Different linguistic properties were selected as predictors [7]. Similarly, our work seeks to assess the text features focusing on the conclusion section of a research report, considering three schemes to evaluate it.

In [8], the aim was to distinguish differences between low and high scoring essays of undergraduate students. They used the Coh-Metrix tool and found that essays with a higher score reflected more sophisticated language and text complexity. In addition, using a holistic approach of quality text in [9], the authors conducted an analysis of four features that together evidence the presence of the construct “idea generation” in student essays. Fluency, flexibility, originality, and elaboration were the elements analyzed. The corpus consists of essays written in 25 minutes by first-year undergrad students, without using external references. The essay assessment was done by different AWE tools such as Writing Assessment Tool, and Tool for the Automatic Assessment of Cohesion. The results obtained indicate that essays with many original ideas (flexible and elaborated) obtained a high evaluation and were significant features for determining the quality of essay. In our work, we evaluate elements of a conclusion, as those described in the pattern, with the aim to help students improve their writings. Similarly, as the work described previously, we identified that the conclusions of graduate level obtained high values of connection to the objective, these being more extensive than those of undergrad level.

We found in a collected corpus that conclusions that obtained high values (Goal Connectedness/Judgment/Speculation) after the evaluation corresponded to graduate students, using a corpus of research proposals and theses. These results suggest that graduate students with better writing skills (lexical richness) [10] also achieved satisfactory results in the features examined in conclusions. Hence, the students who successfully completed a master or doctoral degree seem to possess better writing skills than students of college level. In addition, the result of a pilot test supported the conclusion that the experimental group students obtained better results than those in control group, when guided in the conclusions preparation.

3 Methodology and Corpus

The first step of our study was the creation of a subcorpus of the Coltypi 1.0 collection (coltypi.org) which contains student theses, project and research reports. Coltypi includes documents of Graduate level: Master (MA) and Doctoral (PhD) degree; and Undergraduate level: Bachelor (BA) and Advanced College-level Technician (TSU) (a two-year technical study program offered in some countries). The corpus domain is computing and information technologies. Each item of the collected corpus is a document (in Spanish) evaluated previously by a committee.

Table 1. Text Corpus (words in average).

Level	Objective-Conclusion	Words in Conclusion	Words in Objective
Doctoral	26	584	37
Master	126	577	35
Bachelor	101	419	44
TSU	59	353	40

We gathered for each conclusion of the collection the associated general objective. In total, we had 312 conclusions and 312 objectives (see Table 1). Also, we can notice that on average the conclusions of graduate level are longer than those of undergraduate level. However, the objective section tends to be shorter than conclusions section. To validate our model, 30 conclusions were selected with their corresponding objectives, 15 of bachelor and 15 of TSU level. Each conclusion was manually reviewed for the three elements by annotators.

The annotation process included two annotators, marking the text that reveals the presence of Goal Connectedness, Judgment and Speculation. Each of our annotators had experience in theses review. Next, we show some sentences of undergraduate objective-conclusion tagged by the annotators.

Goal Connectedness (GC) text marked by annotators in a conclusion section:

As we noted earlier, each driver manufacturer has a different method of accessing the internal information, therefore for this reason, the software designed *should be adapted to the driver manufacturer, considering slight changes in the routing of the items (variables) located within the controller memory.*

Speculative text marked by annotators in conclusion (SsP):

Furthermore, as recommendation observe that the GUI can be modified at any time with the right software, with the use of the OPC library (open technology).

For Judgment Model the annotators only write: *Yes or Not presence of Judgment*

The annotator task is complex since each academic reviewer has his own criteria for tagging, adding a certain level of subjectivity to the task. The Kappa agreement between annotators for Goal Connectedness was 0.923 which corresponded to “almost perfect” [11]. For Speculation was 0.650 which corresponded to “substantial”. Finally, for Judgment, the agreement was 0.72 (also “substantial”).

4 Model Overview

The second step was the construction and model evaluation for the conclusion section. Our Model has a Conclusion Analyzer, which contains three main schemes (see Figure 1) and seeks to help students with little or partial experience in drafting conclusions, to assess the elements that academic advisors deem important. In addition to the Conclusion Analyzer displayed on our model, we also include student feedback and recommendations. The suggestions are provided to the student, depending on the level reached in each of the features evaluated. Each of the recommendations was formulated by our annotators, which are higher education instructors with experience in research report and thesis review.

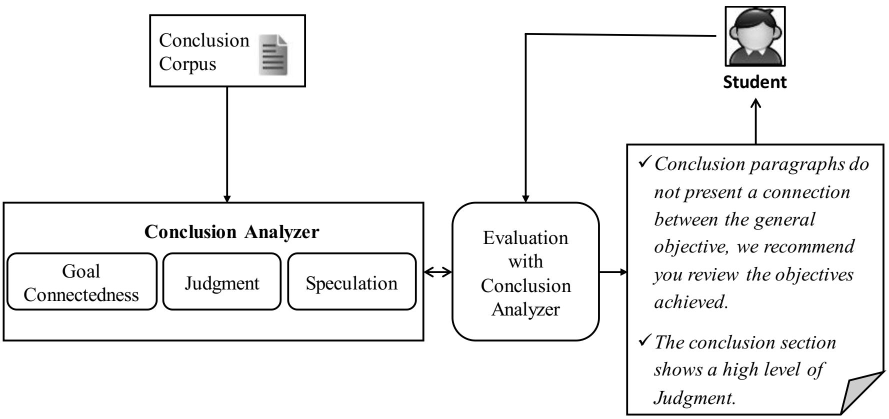

Fig. 1. Model for Conclusion Assessment

Goal Connectedness Scheme (GC): This scheme seeks to identify whether the conclusion shows some connection with the general objective. We expect that some sentences display this relation. So, we target such relations looking for the sentence that best cover the objective. In the first step, we remove function words in input documents, i.e., in conclusion section and general objective. Function words, also called stop words, include prepositions, conjunctions, articles, and pronouns. Also, each term was stemmed with FreeLing (nlp.lsi.upc.edu/freeling), a library of automatic multilingual processing functions, that provides analysis and linguistic text tagging. For the conclusion section, we used a group of sentences, while in objectives we used the full text, i.e. we consider an objective as one sentence. For computing the Connectedness feature, we do it in terms of coverage, applying the expression in Table 2. To evaluate the GC, we processed each of the objective-conclusion pairs with the Goal Connectedness scheme and the result was placed in a scale. To build the scale, the graduate texts were used as a reference, i.e., we processed each objective-conclusion pair, and after that, the average of all results was computed. However, to smooth out the scale, a group of 50 elements of undergrad level was included (selected at random). Finally, to validate the scale, we used the corpus tagged by annotators. After evaluation of the annotated corpus (30 objective-conclusions), we computed the Fleiss Kappa between our analyzer and annotators, obtaining a 0.799 value, corresponding to a "substantial" agreement.

Judgment Scheme (JS): The goal of this scheme is to identify whether the conclusion section shows evidence of opinions. To consider terms that reflect an opinion or value judgments, we turned to SentiWordNet 3.0 since there is no such extensive resource for Spanish. The tool is a lexical resource for English, which aggregates an opinion score to each term (e.g. noun, adjective) depending of the sense. The sense has three numerical scores for objectivity, subjectivity and neutrality. The range of values is between 0 and 1. Each conclusion was translated to English employing Google Translator (A study of four services using Spanish to English translation showed that Google was superior [12]). After translation, empty words were removed and the value for each sentence was computed. To obtain the measure of each sentence, we search each term in SentiWordNet. To evaluate the JS, we took again the graduate level texts as reference to define a scale. However, in this case, we do not smooth, as we have three levels of opinion. For this feature, the conclusions must reach the average level of review, this will give evidence that the student is expressing judgments and opinions in the conclusion paragraphs. We computed the Fleiss Kappa between the results of our analyzer and annotators (30 objective-conclusions pairs), reaching 0.65, a "substantial" level.

Speculation Scheme (SpS): The model aims to identify evidence of sentences that describe future work or derivations of the research. For this purpose, we resort to two lists of speculative terms. The first list includes lexical features provided by [13]. The second list was obtained from the "Bioscope corpus", consisting of three parts, namely medical free texts (radiology reports), biological full papers, and biological scientific abstracts. Both lists are independent of our corpus. The dataset contains annotations at the token level for negative and speculative keywords [14]. The corpus was tagged by two independent linguists following guidelines. After extraction of speculative terms, we combined the two lists, with the goal of gathering a more exhaustive list. Each term of the merged list was translated, producing a list of 227 speculative terms. To evaluate the Speculative feature, we processed each of the conclusions counting the speculative terms in each sentence. Only the coincidence level between the text marked by the annotator and the sentence with maximum number of Speculation terms was described. After analyzing the annotated pairs using the criterion described, we computed the Fleiss Kappa between the results of our analyzer and the annotators (30 pairs), obtaining a result of 0.887, i.e. "almost perfect" agreement.

Table 2. Text Corpus.

Model	Parameters	Expression
Goal Connectedness	Absence of connection <0.12 0.12 < Acceptable < 0.41 Strong connection > 0.41	$C = \frac{\#(So \cap SC_i)}{N}$ C = Coverage *So* = List of words in objective SC_i = Sentence i of conclusion *N* = Number of terms in the objective
Judgment	No Judgment < 7.84 Yes, presence of Judgment > 7.84 < 26.98	$T = \sum Wi \left(\frac{On + Op}{N}\right)$ T = Score* O*n* = Negative Score; O*p* = Positive Score N = Number of occurrences (noun, pronoun) W*i* = each word of sentence

5 Conclusion Analysis in Practice

After the corpus exploration and evaluation of methods to assess conclusions, an online system was developed with the goal of validating the models and identifying if the tool could help students to improve their writings. The computational tool TURET2.0 (In Spanish: Tutor Revisor de Tesis) is hosted at tutor.turet.com.mx. Any student can register and use the system. In addition, TURET2.0 has a section that explains its use and provides support material for the student. The support material gives the student an explanation of the elements evaluated by the system.

In the system interface, the student submits the objective and conclusion of his report. Subsequently, the system sends the results of the analysis back to the student indicating if the score reached is acceptable. The student can repeat the analysis and each attempt is recorded. In case of no evidence of Judgment, the system provides the following text "Opinion is very important in a conclusion, to achieve an acceptable level of judgment, improve the conclusion by incorporating sentences that contain your value judgments". In case of Goal Connectedness was strong, the system sends the message "The connection value is strong between your objective and your conclusion. Congratulations, you have achieved an excellent score". The system was created with Django, Python, and libraries for text analysis.

5.1 Pilot Test

We designed and performed a pilot test to assess the impact/benefit of using an online application focused on Goal Connectedness, Judgment and Speculation in a conclusion section of a research report. The experiment involved undergraduate engineering students. Also, we considered two randomly selected groups, one experimental, and other for control, each with 15 students. The two groups received instructions on how to write a conclusion section. Students were informed of each key feature, using the triangle pattern of conclusion section. The control group had a traditional monitor, that is, an academic advisor reviewing their documents, while the experimental group had access to the intelligent tutor 24 hours a day. All documents produced by both groups were evaluated with TURET2.0 to compare the results among them. The foremost hypothesis to be validated in this pilot test was: "The use of an online application, allow students in the experimental group generate documents with better parameters, in terms of the features.

One can notice that the experimental group produced higher values on each feature than control group. These results provide evidence that students of experimental group reach twice the values of measures. It was also observed in the experimental group that on average, the number of attempts of TURET2.0 use was 8. However, when we observed the standard deviation, in the control group we found that it was lower than the experimental group. This could indicate that the control group is more uniform in performance. It is possible that in the experimental group some students using a technological tool (TURET) allow them to achieve superior results, while other students have an average performance on the test. Also, we performed a statistical analysis to validate the results. We applied a hypothesis test for two independent samples with different standard deviation.

The confidence level was 95%. We carried out the hypothesis test for each measure. For the three features, the null hypothesis was rejected with P-values of 0.046 (Goal Connectedness), 0.020 (Judgment), and 0.024 for Speculation feature. These statistical results indicate that the null hypothesis is rejected for the three characteristics. The TURET2.0 system allowed students to achieve higher measures than the students in the control group.

In addition, a correlation analysis was performed among the three characteristics in the two groups. In Table 3, we can observe a correlation of the experimental group which is quite close to the correlation identified in the annotated corpus. The characteristics of Goal Connectedness-Judgment show a positive correlation with significance in the annotated corpus and in the experimental group, i.e. a value of 0.609. The result of Goal Connectedness-Speculation shows that there is no correlation, as is the case of the annotated corpus. We can assert that the students wrote conclusions with a closeness to the pattern of conclusions, since the correlation numbers were close to those of the annotated corpus.

Table 3. Experimental and Control Group Correlations

Features	Experimental Group		Control Group	
	Correlation	P-value	Correlation	P-value
G. Connectedness-Judgment	0.609	0.016	0.36	0.187
Judgment-Speculation	0.535	0.04	0.042	0.881
G. Connectedness-Speculation	0.223	0.424	0.339	0.216

For the students of the control group no correlations were found, which indicates that control students should continue working with the writing of their conclusions, to reach acceptable values. We also applied a satisfaction survey based on Technology Acceptance Model [15] to assess the opinion of the experimental group on using the online analyzer, in the aspects of usefulness, ease of use, adaptability and intention to use the system. Students answers were based on a five-point Likert scale ranging from 1 ("Strongly disagree") to 5 ("Strongly agree").

The average results were: 4.46 for system usefulness, 4.33 in system ease of use, 4.25 in system adaptability and 4.11 for intention to use the system. That is, the four aspects of the survey were above 4 points ("Agree"), so we can conclude that the analyzer was found useful, easy to use, adapted to their level and students have the intention to use it. However, in student comments, it was found that some of them felt the registration was complex, primarily because of its registry process.

6 Conclusions

We have presented a Model that uses NLP techniques to evaluate the conclusion section, that was designed to consider specific features of writing. Our model could help improve the writing of research report by undergrad students or inexperienced learners, regarding Goal Connectedness and Speculation, since the achieved Kappa levels were substantial or better.

The pilot test with engineering students in the systems area allowed us to bring the developed schemes to a real environment. We can identify, as a result of the pilot test, that the students of the experimental group showed interest in using the tool and improving their writing. Such interest was observed in the average number of the times that the students used TURET2.0. However, it could have also been due to the competition generated amongst the students of the experimental group when using the system, as results can be improved when using the tool.

One of the constructs that were best evaluated in the satisfaction survey was the usefulness that motivates us to continue with this project. The intention to use construct was the lowest, so strategies to increase this metric were sought, for example, the incorporation of serious games strategies [16]. The results of the correlation analysis between the two groups (control and experimental) validated to some extent the similarity with the pattern of conclusions detailed in the introduction. One finding was that the Goal Connectedness and Judgment measures showed a positive correlation with significance, such as that found in the annotated corpus, where the documents were theses or research projects reviewed previously by a qualified committee.

Furthermore, we are also planning to include metrics to assess whether a conclusion contains a certain level of originality and elaboration [17]. The working hypothesis is that the conclusions of graduate level contain more original ideas.

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Artificial Intelligence and Commonsense

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Abstract. The use and development of artificial intelligence (AI) capabilities in a company's production environment is critical to improving assembly process times and product quality. Manufacturing processes are complex and require highly skilled operators to build quality products. Production processes and engineering designs are even more complex and new methods must be employed to address these complexities. AI technologies hold promise to address these complexities using 'commonsense' knowledge (CSK) tools. Implementing and using CSK capabilities has accelerated the growth of AI applications in industry. The development of AI capabilities has been a slow and painstaking process in its attempt to fully mimic the capabilities of humans. However, there is much work to be done to duplicate human process capabilities in an AI system. As new technologies are developed and made available to the design and development engineers, the acceleration and growth of AI capable systems will grow exponentially.

Keywords: artificial intelligence, commonsense knowledge, complexity, engineering designs, product quality

1 Introduction

The design and development of AI capabilities has been a formidable task for over a half century. AI developers face the challenges related to the digital capture of human-based CSK [4]. Some of the early researchers in AI include John McCarthy, Marvin Minsky, Nathan Rochester, Alan Turing, Arthur Samuel, and Claude Shannon. They had a daunting task which continues today of determining how to utilize the existing technologies of their day to create AI capabilities by using computational logic to capture and classify normal human CSK reasoning [11]. Because computational technology capabilities have expanded greatly since the 1950s, the development of AI and machine learning technologies (expert systems) have continuously improved [7]. One of the initial expert systems, an early form of AI, was the MYCIN system, used in the medical profession. The MYCIN system is a program consisting of many patient symptom questions used to best advise

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physicians diagnosing and treating blood diseases [2]. Companies and academia across the world are investing significant capital funds to make breakthroughs in AI capabilities in the quest to have machines perform most or all tasks that humans do today. One of the key foundational requirements in the design of an AI expert system is the use of 'CSK' elements. This research study will investigate these elements associated with AI systems.

2 Defining CSK

Implementing AI capability requires the development of an 'expert system'. An expert system utilizing CSK knowledge data, requires the use of mathematical-based probability and inference theories, applied to random processes and samplings in AI and machine learning systems [3]. An expert system must be able to perform processes such as [8]: perception, interpretation, reasoning, learning, communication and decision-making in order to arrive at a solution for the given problem. The design of an expert system is the combination of stored human expert knowledge and intelligent database content where knowledge is used to solve problems, but this expert system design lacks the ability to address unknown or undefined situations [2, 12].

The design of an AI system improves upon the use of stored information and the use of CSK knowledge to address new and undefined situations, conditions, or problems [12]. John McCarthy proposed that if a technology is to be defined as AI, it must demonstrate an ability to perform CSK reasoning, the use of mathematical logic, and the use of inference logic applied to its assemblage of knowledge resources [11]. An AI system uses CSK knowledge, stored information, and deductive capabilities to solve problems and develop new knowledge that would typically require significant human capital investment to achieve [8].

3 CSK in AI Applications

The progress in developing effective AI applications has been slow. The availability of new computational, visual, audio, and sensor technologies has greatly accelerated the abilities to develop many new types of AI capabilities. However, the significant scientific and engineering challenge relates to the intricate workings of the human brain. There are many functions and capabilities of the human brain that are still unknown, but research continues to discover and expand the knowledge base of these functions. There are several approaches taken to classify and document events when translating human mental and physical abilities into digital data. One approach taken, as noted by McCarthy, is the construction of mathematical models. The other approach was analysis of pattern recognition, used by Minsky. Both of these approaches fit into the realm of developing a large repository of CSK elements which will enable computational devices and machines to function independent of human intervention.

The development of AI capabilities is dependent on the analysis and understanding of CSK knowledge within the context of an expert system. CSK knowledge "can be viewed as a collection of simple facts about people and everyday life, such as 'Things fall down, not up', and 'People eat breakfast in the morning'" [9]. Reasoning of CSK knowledge in AI systems is critically dependent on the use, understanding, and context of natural language, digital visual image interpretation, and robotic action/reaction to unanticipated situations [1, 3, 4, 5]. The formidable task in the development of an effective AI system is the central problem related to the computational analysis, understanding, and reaction to the accumulated expert system data and the accumulated CSK [9].

In order to make AI applications more effective and useful, the application developers must construct a significant data file of CSK knowledge content. With the AI design "many tasks that humans can do, humans cannot yet make computers do" [10]. There has been substantial progress made in four areas related to CSK reasoning/knowledge in AI [3, 4]:

- Reasoning about taxonomic categories – collection of categories and individuals and the relations between them. The interrelations include: a dog is a mammal, which is an animal – one is a subset of the other. This is a simple taxonomic structure which is used in AI programs. Besides subsets, other elements would include: instance, disjoints, properties, transitivity, and inheritance. An example would include web mining searches to collect CSK knowledge from web documents.
- Reasoning about logic – the strategies used as a theoretical framework to encode CSK knowledge can be expressed symbolically and reasoning can be characterized. The components of logic are: syntax and symbols, mathematical semantic characterization, and a CSK inferential sequence of axioms.
- Reasoning about time – temporal reasoning representing knowledge and automating reasoning about times, durations, and time intervals is a largely solved problem. One difficulty relates to natural language interpretation, which is complex and context dependent.
- Reasoning about actions and change – events are atomic (one event occurs at a time), every change is a result of an event, events are deterministic, single actor, and perfect knowledge. The domains that satisfy these constraints, the problem of representation and important forms of reasoning such as prediction and planning, are largely understood.
- Reasoning about space and sign calculus – CSK spatial reasoning includes visual cues, robotic manipulations, physical and biological reasoning, and folk psychology and sociology. There are two forms of sign calculus used in CSK reasoning processes. Situation calculus uses a branching model of time to characterize planning with alternative possible actions. Whereas, event calculus,

uses narrative interpretation - events are treated as atomic where the order of the events is known.

The implementation of CSK knowledge capabilities into AI systems is critical to the further development and improvement of process controls. The implementation of CSK processes “represents the base level of context that one can assume by default, exclusive of specialized domain knowledge and user-personalized details” [9]. One of the most difficult tasks in AI development is the issue of ambiguity. The configuration of a large set of CSK knowledge data must consider the “disambiguation in a number of natural language and speech interfaces” [9].

4 Proposed Enhanced Form of Educational Technology

The incorporation of CSK capabilities into AI applications in industrial processes and instructional designs can enhance the overall manufacturing capabilities. The integration of AI and augmented reality (AR) technologies in training and industrial applications can enhance overall productivity processes and product quality. These technologies are enhancements that are slowly being implemented in many industries. AI and AR enhanced processes can be used in instructional training as well as in the production environment.

Technologies such as iPhones, iPads, and smart glasses use AR application capabilities to enhance an operator’s skills when performing process tasks. These technologies enable the user to complete process tasks without being dependent on external resources. The CSK enhanced AI/AR technologies are used to develop what is being termed the new digital factory or Industry 4.0 [6]. The design of this type of AI/AR technology would digitally integrate all aspects of a manufacturing task requirements into one expert system [6, 8]. All of the drawings, procedures, planning, checklists, and process final acceptance would be integrated into one software application. As the operator works through a process task, whether on the production floor or in a training environment, the AI/AR expert system would be utilized to complete the operations of a given task.

The AI/AR interactions would include process checks to ensure the operator is completing the manufacturing process steps in the correct order and continuously check the ongoing assembly process to assure that all of the task steps are completed before the operator moves on to the next operation. Throughout the task process, the AI/AR capable system can check and measure the overall process performance and make suggested process improvements to address process times and product quality issues.

The AI/AR expert system would include the virtual display of the process drawings, procedures, planning, checklists, and final acceptance for the operator. The operator would use the built-in features of the application to display all of the required documentation necessary to complete the process task(s). An additional feature is that in conjunction with the AI/AR application capability, the production parts will have virtual overlays that guide the operator through the complete assembly process. The integrated design of the AI/AR expert system in a production assembly process can be simulated in the classroom to train the operator in the complete end-to-end process. The benefit of the AI/AR production design is that the application is used to enhance the learning environment during the initial operator training as well as the actual production task process. The overall benefit of the AI/AR expert system is that the instructional content of the application is the same as the actual production content so as to maximize training and task effectiveness and efficiency.

5 Added CSK Features

One of the key CSK features that can be added to an AI/AR expert system is the ability to capture all of the process steps used to complete an assembly process. Research studies at MIT have implemented AI capabilities that include [9]: predictive typing, speech recognition, natural language understanding, end-user programming, activity recognition from sensor data, interface to other networks, online helps, and live video conferencing capabilities. All of these capabilities are available and used currently, to some degree, throughout industry.

With the mix of generational workers in industry today, companies are faced with many of its employees at or close to retirement age. A big concern is how the company can capture the CSK and operational knowledge of its older workers before they retire. Many of the company's production processes are done by older employee operators that have performed these tasks many times. These operators have developed a skill base that is not formally documented. Implementing CSK measures in the design of the AI system will enable the successful knowledge capture of these older workers as they perform their daily tasks. The AI/AR system can capture and compare the engineering, manufacturing, and planning requirements to the way the operators perform their process steps. The AI system can decipher the differences between the two and formulate suggested process changes and improvements to enhance build times and product quality. Once the knowledge of the older operators has been captured and validated in the AI system, the instructional designers can revise the instructional content and the design engineers can revise and update the engineering and manufacturing process requirements. The capabilities of an integrated AI/AR expert system can minimize the learning curve of new operators by having a well-defined instructional design as well as maintaining up-to-date engineering process requirements used by the operators on the production floor. Without capturing and integrating the CSK skills of the older operators into the AI/AR application, the new operators are more susceptible to making mistakes and producing poor quality products while they are learning these new skills.

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Can Fragmentation Learning Promote Students' Deep Learning in C Programming?

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Abstract. In order to reduce students' difficulties in programming learning, this study developed a mobile platform called Dquiz with the advantage of distributed effects, which can provide 2-3 multiple-choice questions per day. The study applied it to C programming courses and explored whether the system can improve students' learning outcome and which factor influence the outcome. A total number of 74 freshmen were randomly divided into two groups. One group can practice every 3 days at least. The other students practice once a week. Both groups of students practice the same number of questions. The result showed that the students who used the platform several times a week score higher than students who used it once a week. The factors that affect students' learning outcomes during their practice include intervals of platform usage, correctness and the total number of comments.

Keywords: programming learning, practice platform, mobile learning, fragmentation learning

1 Introduction

Cultivating computational thinking is becoming an important issue widely concerned over the field of education. In higher education of China, programming is the most important way to cultivate computational thinking. It becomes a foundation course for all students. However, for beginners, learning a new programming language is difficult because of the complexity, abstraction, and flexibility of programming languages. Moreover, every topic of programming is closely related. Students would be lost in the next topic if they don't master the previous topic. Confusion about syntax and algorithms can reduce the efficiency of students' programming, and even lead to a problem that some students afraid to program after the course. It is necessary for novices to spend more time practicing basic knowledge. Continuous practice can help students retain knowledge [1].

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In China, there is usually scheduled 2-4 hours per week for non-computer students to learn coding in the classroom, which is far from enough for students to practice, so finding some new way to learning programming is necessary. According to statistics, up to 90% of students have their own mobile devices [2]. Using mobile devices to support students' practice is a feasible solution, which can make full use of the fragmentation time of students. Therefore, the study developed a mobile platform for students to practice C programming anytime, anywhere. However, some scholars worry that fragmentation learning can lead to students' learning content become scattered. This kind of learning lacks depth and breadth, and it is difficult to form a holistic and systematic knowledge system and promote deep reflection of learners, which is not conducive to application, and migration of knowledge [3]. Therefore, in the fragmentation learning environment, how to design an effective tool to guide students to learn in depth is worth considering.

This research aims two questions. 1) Finding out how to design and developed a mobile platform to support students to practice basic concepts and algorithms of programming in the fragmentation learning environment. 2) Exploring whether fragmentation learning can improve the performance of students and understand the factors that affect students' learning.

2 Literature Review

In programming learning, practice is beneficial for the novice to master the basic facts, features and being able to consciously plan and carry through a problem solution in specified areas [4]. However, the invalid practice not only wastes students' time but also result in cramming. Dunlosky and Rawson suggest that effective practice need to consider both content and time of practice [5]. As mentioned above, the free time of students is limited and the knowledge of programming is related closely, so it is reasonable to select the most important concepts for practice tests and the practice need to cover the prior knowledge, which require students to retrieve from long-term memory. Through continuous extractive exercises, students can better retain basic knowledge. It is better to use free recall or short-response formats, such as multiple-choice questions, which can help provide learners with clues to extract in the final performance [6].

Students can benefit more from the practice with feedback. Giving feedback about the reason why the answer is correct or incorrect can increase the proportion of correct responses and correct erroneous answers [7]. Students can view the content of discussions, compare their opinions with others' opinions and reflect on their leaning. Through feedback of system and communication between peers, students can solve problems that encountered in programming practice timely. This will not only help them learn the next topic better but also enhance their confidence.

There are many platforms for students to practice in programming learning. For example, Hovemeyer and Spacco introduce CloudCoder to the classroom, a web-based programming exercise platform, which designed for reinforcing concepts and mastering basic skills of novice [8]. A typical problem asks the student to write a function or complete program to perform a simple task. Pritchard and Vasiga offer Computer Science Circles for beginner to practice. The platform can offer kinds of exercises formats like short answer questions and multiple choice as well as coding exercises. In the system, students can also ask the teacher for help so that they can receive feedback timely [9]. Marcelino et al. develop an application called H-SICAS. It is a handheld algorithm animation and simulation tool and students can build and simulate his own algorithms [10]. Tillmann et al. introduce TouchDevelop for students to programming [11]. It can also allow students to publish, download and discuss the programs.

Teachers often use these platforms to post a large number of assignments, and most students tend to log in the system to complete these practices at once. Although the mass practices make learners get better performance immediately after the end of learning, it can't promote the retention of knowledge [12]. The much better approach to improving the efficiency of practice is that spreading the practices over a period [13].

Fragmentation learning is consistent with this kind of practice that is defined as distributed practice [14]. It has been shown in existing researches that distributed practice is effective for mastering knowledge and developing complex skills [15]. Hsiao's research team has developed a web-based platform, QuizIt, which supports distributed practice for novices on C programming. The platform provides students a multiple-choice question to practice every day. The data showed the positive effect of learners' usage of the tool [16].

However, it is not convenient to use the computer to practice, students will spend a lot of time in the process of starting the computer and platform. Our previous study found that students are more willing to practice with mobile devices [17]. Studying anytime and anywhere can enhance the students' learning experience and commitment [18]. Therefore, it makes sense to develop a mobile platform to support fragmentation learning that students can practice a small number of topics at anytime, anywhere.

3 Design of Dquiz

3.1 Architecture of Dquiz

Dquiz system is a mobile platform inspired by QuizIt. It was developed using HTML5 so that it can be applied to different systems. The platform architecture can be divided into three major contents: presentation layer, business logic layer, and data layer (see Fig.1). The interface layer is an interface between the user and the system. Students or teachers can access the server through a mobile terminal and communicate with the data of the server. The business logic layer includes information management module and interaction module, mainly processing the request from the application layer. The corresponding database information is called according to the request, and the result is fed back to the application layer. The data layer responsible for storing and providing data, which is mainly composed of the user information database, exercise database, forum database, and students' behavior database.

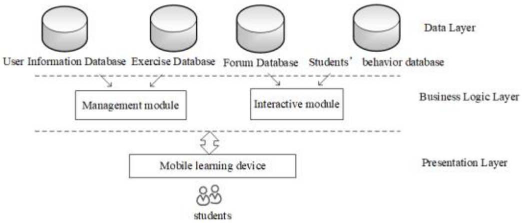

Fig. 1. Architecture of Dquiz

3.2 Function design of Dquiz

Dquiz mainly consists of two modules: student module and teacher module, the functions of the two modules were described below.

Student function module. The functions of the student module mainly include practice and discussion. When students log in the platform, they can see a calendar interface showed Figure2. There are different color squares on the calendar to represent the students' state of practice, which can help students judge whether they have completed the practices. Then, students can choose any date from the calendar to enter the exercise interface and complete the exercise of that day. The practices are presented in the format of multiple-choice questions (see Fig.3). The multiple-choice question can enhance retention of the materials tested and boost performance on later tests [6]. The study offers different types of multiple-choice questions so that students can cultivate different abilities. For example, students need to analyze the results of program output, supplement programs and find out the errors of the program. These exercises require students to read and analyze a complete program, which can help students understand grammar, semantics, and algorithm. Dquiz can offer 2-3 fixed practices per day and students could practice for a few minutes each time anywhere.

After the students submit the answer, they can receive simple feedback on the fact whether the answer is correct or not. Students can also check the answer, answer explanation, or collect the question when they finish the current exercise. Providing appropriate explanations for each alternative in the multiple-choice question can enhance students' learning [19]. Then, students have a choice to access to other questions of the day or jump to a certain date by the buttons of the previous day, the next day or the calendar.

Fig. 2. Calendar interface

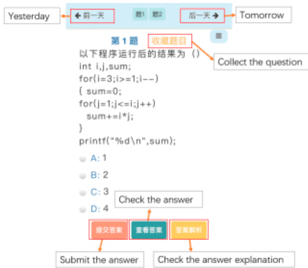

Fig. 3. Practice interface

The practices that students have done will be automatically generated in the review area (see Fig.4). The topics in the review area will be organized according to the knowledge points of the course. The questions that students have made wrong will also be marked accordingly. Students can choose the appropriate practices according to their mastery level of knowledge.

In order to encourage students to share their knowledge with each other, Dquiz provides a forum below each question for discussion (see Fig.5). When the students complete the exercise, whether they are right or wrong, the student can enter the forum to ask questions, answer questions and praise a question or an answer. According to the learning situation of each student, the system will award different levels of medals to the students. Giving Students medals can help students to monitor their learning progress. Novices who are able to monitor their own learning can help them learn conceptual and strategic knowledge so that they can program better [20].

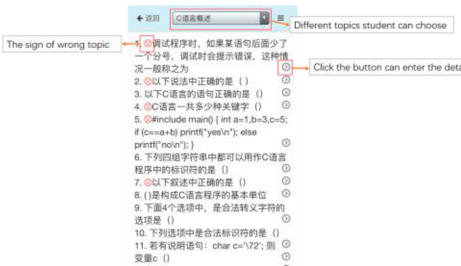

Fig. 4. Review interface

Fig. 5. Forum interface

Teacher function module. There is a web-based management platform that is used by teachers to set questions and monitor the learning of students. Teachers can not only check the correctness of each student, but also each question. The correctness reflects the level of students' mastery of knowledge. The teacher would explain some questions that correctness is lower. Moreover, Students with low correctness or slow progress can be promptly reminded and instructed by the teacher or assistant.

4 Evaluation of academic performance

4.1 Data collection

The management platform recorded all learning activities of students with a timestamp. The study classified all data into five indicators, including the interval of platform usage, the total amount of practice, the total number of comments, online time and correctness. The specific indicators are shown in Table 1. A five-point scale was used to understand the student's programming basis and other study time that students spend on the C programming learning after class expects using Dquiz. At the end of the course, the students took part in the standard unified examination. The final exam score was used to evaluate students' performance.

Table 1. Indicators of students' activities.

Indicator name	Description
Interval of platform usage	Average number of days between two consecutive practice
Total amount of practices	Total number of topics a student practice on average
Total number of comments	Total number of comments made by a student
Online time	The time a student spends on Dquiz
Correctness	The percentage of a student's correct responses on his all submission

4.2 Methodology

The research has involved 74 freshmen students, including 27 boys and 47 girls, of Beijing Normal University majoring in non-engineering and participated in the course of C programing language. Their average age was 19.09(SD=0.50) years old. The course lasted for 16 weeks. Students should take the course once a week and each class spent 210 minutes, with 10 minutes break every 45 minutes. The study provided students with Dquiz and they were all willing to use Dquiz as a tool for practice. The students were randomly divided into two groups. Both groups of students practice the same number of questions every week. The difference is that the experimental group needs to practice every 3 days at least, while another group just need to complete the practices once a week. The number of questions that are available for students to answer is 225 and the topic is determined by the teaching progress. At the end of class every week, the teacher would require the students to complete this week's exercises on the platform before the next class. The teacher uses the data recorded by the system to check whether the student completes the exercise as required. For the unfinished student, the teacher will give a reminder with instant messenger.

4.3 Result

The study firstly performed a t-test to explore the differences in performance of practice and learning outcome between two groups. The result is shown in Table2. It indicates that there was no significant difference in the basis of programming between the two groups before taking the class. The programming basis of the experimental group is 2.00(SD=1.18) and the control group is 1.73(SD=0.95). However, there was a significant difference between the two groups in learning outcome, the interval of platform usage, the total number of comments and correctness. The average final exam score of the experimental group is 84.73 (SD=11.95) and control group is 72.67 (SD=15.66). In terms of the performance on the system, students of the experimental group used the system to practice every 3.31 days (SD=1.55) and control group students practice every 7.99 days (SD=2.99). Figure 6 shows the number of students using Dquiz per day for both groups of a semester. The results showed that the practice time of the students in the experimental group was distributed in different time periods of the week, while the practice time of the students in the control group was periodic, basically concentrated on Thursday. Both groups practiced more on Thursday because it is the time of C programming course. The total number of comments experimental group posted and reviewed, on average, is 22.68 (SD=21.33) while the control group is 12.86 (SD=9.87). The experimental group's correctness of practice in the system is about 67% (SD=7%) and control group is 61% (SD=2%).

Table 2. T-test between experimental group and control group.

	experimental group(N=38)		control group(N=36)		t-value
	M	SD	M	SD	
programming basis	2.00	1.18	1.73	0.95	1.06
Final exam score	84.73	11.95	72.67	15.66	3.74***
Interval of platform usage	3.31	1.55	7.99	2.99	-8.37***
Total amount of practices	224.29	3.66	224.53	1.59	-0.44
Total number of comments	22.68	21.33	12.86	9.87	2.56*
Online time(min)	981.90	846.37	827.42	658.52	0.87
Other study time(min)	338.03	236.42	309.17	198.73	0.57
Correctness	0.67	0.07	0.61	0.02	2.84**

*p<0.05, **p<0.01,***p<0.001.

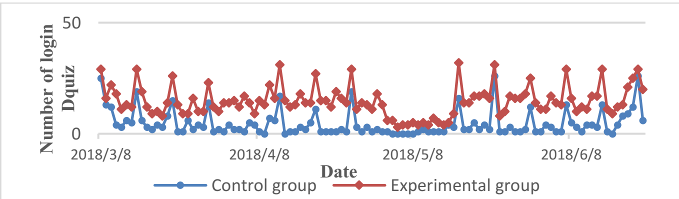

Fig. 6. The number of students using Dquiz per day for both groups

In the next place, the study calculated the correlation coefficient between the indicators and learning outcome. The result described in Table 3. The study can find that interval of platform usage had a negative correlation with outcome. It means that the shorter the interval, the better the students' learning effect. Other factors including the total number of comments and correctness are both positively associated with final exam score.

Table 3. The correlation between all indicators and final exam score (N=74).

	Interval of platform usage	Total amount of practices	Total number of comments	Online time(min)	Other study time(min)	Correctness
Final exam score	-0.42**	0.23	0.33**	0.20	0.55	0.71**

*p<0.05, **p<0.01.

5 Discussion

The Dquiz is designed to give students more opportunity to practice anytime and anywhere. The study expects the platform can promote students to understand the basic concepts and algorithms of programming, and thus improve the results of students' programming learning outcome. The result of data analysis is in line with our expectation. Students who complete the practice several times per week perform better than students who practice once a week when both of them practice the same number of questions. Moreover, the correctness of the experiment group is higher than the control group. The result is in accordance with the opinion that distributed practice is more effective than massed practice [14]. There will be some interval between exercises when students distribute practices over a period. Intervals can cause students to forget, which makes more difficult for them to extract information next time [21]. In other words, students who adopt a distributed strategy will input more time and energy to retrieve related information from memory when they are practicing. By connecting old and new knowledge and reprocessing knowledge, students can deepen their understanding [22]. Therefore, although fragmented learning leads to fragmentation of learning time and learning content, if organizing learning materials systematically and structurally and providing clues every time to guide students to connect new and old knowledge, it can help students to transform fragmented knowledge into systematic knowledge and achieve in-depth learning.

Dquiz also provides a forum for students to communicate so that they can share opinions and discuss questions, which can help students to construct individual knowledge and to reflect on their own learning [23]. Reflective learning promotes the understanding, application, and migration of knowledge, and ultimately reaches the level of deep learning [24]. The data showed that the number of comments on the experimental group was higher than the control group. It indicates that students in the experimental group are more willing to devote themselves to discuss the questions online. Students can discuss a topic during each practice, which not only helps students solve problems, but also improves their learning engagement. Studies have shown that students with higher participation are more likely to adopt deep learning strategy [25].

6 Conclusion and future work

This study developed a mobile platform and applied it to the C programming course. The study found that students who use the fragmented time to practice topics that are organized systematically in the platform, can improve their learning outcomes in C programming. The factors that affect students' learning outcomes during their practice includes intervals of platform usage, correctness and the total number of comments. Further discussion found that students with frequent usage engage more in practice. They work hard to extract information and reprocess information so that they can deepen understanding and retain more knowledge.

In the future, the study will further study the online behavior patterns of students, and explore deeply the impact of students' online learning behavior on learning outcomes.

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Challenges in recruiting and retaining participants for smart learning environment studies

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Abstract. Conducting studies to assess the efficiency of smart learning environments, including learning analytics tools, is essential to the success of this emerging field. Recruiting and retaining research participants is fundamental to obtaining meaningful results from such studies, and yet, this remains a major challenge. Understanding the research participant enrollment experience, their satisfaction with the study information received and with the research staff, and their intent to promote and participate in future similar studies are important factors to collect and report to tailor recruitment strategies and experimental designs that would attract more participants in studies with smart learning environments. This paper reports the results of participant satisfaction to a study on java programming involving a suite of learning analytics tools. Answers reveal a high satisfaction level among participants, though the participation rate of the study was very low.

Keywords: recruitment • retainment • satisfaction • motivation • research participant • computer science • smart learning • learning analytics

1 Introduction

The challenge of recruiting and retaining participants in research studies is well known and documented [1, 2, 3]. Several researchers, mostly in the medical and psychology fields, have reported their recruitment process, lessons learned, proposed strategies as well as the research participant satisfaction over their study process [4, 5, 6]. However, finding such participant satisfaction reports in studies conducted in Science, Technology and Computing is quite rare, even almost nonexistent. With the rising popularity of smart learning environments (SLE) – including learning analytics tools – in educational institutions, careful examination of these tools to

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study and measure their benefit on learning, and to gauge needed improvements in the tools, is becoming a compelling necessity. Yet, finding research participants for such studies in postsecondary institutions remains a challenge. The purpose of this paper is therefore twofold: 1) reporting the recruitment and retainment process in a study involving a suite of learning analytics tools [7] and the research participant satisfaction over this process along with recommendations; and 2) encouraging researchers in the SLE field to survey their research participant satisfaction and report this important segment of their study to help the SLE research community develop recruitment and retainment strategies specific to this field or find alternative experimental designs that would alleviate this challenge.

2 Study Context

2.1 Procedure and Participants

Students from the School of Computing & Information Systems at Athabasca University, Canada (an open university offering online and distance education), were invited through various means (email, university webpages and social medias) to voluntarily participate in a research study about the impact of a suite of learning analytics tools on students' performance in Java programming [7]. Invitations included the link to the study website (http://lambda.athabascau.ca/jav.au/), which provided clear and detailed information on the study with the possibility to inquire by email for further clarification. A Register button was leading to the consent and registration form with a few demographic and educational background questions, with participants selecting either a student or tutor role in the study. Upon submitting the form, a contact person started a follow-up process with that participant. The recruitment period closed after seven weeks (mid-May to early July) in 2017. And, the study, which was intended to last four months, had to be extended for another two months to allow for more participants to complete the study requirements.

In spite of significant financial and prize incentives ($200 after fulfilling the study requirements, and a possibility to win 1 out of 5 tablets for highest grades) that had to be justified to the Research Ethics Board due to their unusual high value, there were only 148 participant registrations out of about 1000 potential participants (students enrolled in at least one computing course). At the end of the study, 67 participants completed the requirements (students: n=48; tutors: n=19), meaning that 66 either withdrew or dropped out during the study period. All 67 participants reported their demographic information except for one who entered an invalid birth date. Most participants aged between 18 and 50 years old ($\bar{x}$=34; Mo=22), were from Canada (n=65; 97%) with English as their first language (n=60; 90%), and approximately three-quarters were male (n=51) and one-quarter female (n=16).

2.2 Recruitment and Retainment Strategies

This section briefly describes several recruitment strategies adopted in this study that are recommended by the Higher Education Quality Council of Ontario, Canada [2].

First, recruitment strategies should incorporate major motivations of research participants across genders: 1) the study at stake is worthwhile and meaningful – the study website highlighted that this study would help researchers better understand how to aid students to be more efficient and successful in programming, 2) the targeted participants have an interest in the study – students registered in computing courses were targeted, and 3) the participants are gaining benefits – incentives included a fair financial compensation following the rule of thumb that it must be equivalent to a working wage (rate close to Alberta's minimum hourly wage of $15) for the estimated time and effort (15 hours) [5], the possibility to win 1 out of 5 tablets (worth about $1200), and the offer to obtain a summary of the results at the end of the study. Moreover, this study was announced through several modes of communications including direct (targeted emails from the faculty, course coordinators, research assistant) and indirect methods (university webpages, course management system, social media), thus reaching all students registered in computing courses at Athabasca University, Canada. This study also provided easy and continual online access to the study information, which was deliberately offered in a language easy to understand, to the point, without any exaggeration, and in an easy-to-read format with visuals, thus helping participants to make an informed decision. Surveys used in this study were easy to access, included realistic time estimates (maximum of 20 minutes as recommended), clear indication of the number of questions, and a progress bar to encourage completion. Realistic time estimates were also provided for other study requirements (e.g. coding assignments). Besides, a research assistant was assigned as the main contact point for this study, ensuring that participants receive prompt answers from the start to the end of the study period.

However, two aspects of this study design were contrary to the recommendations by [2]: 1) it was announced at the end of a semester; and 2) all study requirements were additional to normal course activities.

2.3 Instrument and Data Analysis

An adaption of the Research Participant Satisfaction Survey originally developed to capture research participant experiences of an Academic Medical Center [6] was used to survey participants enrollment experience and satisfaction over the research process in this study. Separate instruments were used to assess their satisfaction of the educational experience and learning analytics tools, which will be reported in a subsequent paper. The survey data reported in this paper were collected in the LimeSurvey tool and exported as Excel files, with the descriptive statistics computed using the Jamovi software [8].

3 Results

All 67 participants (tutors and students) answered all questions in the Research Participant Satisfaction Survey, meaning that there were no missing answers.

The first section surveyed participants on the means by which they learned about the study. Results indicate that most students (n=55; 82%) learned about the study via an email from their course professor, the study's lead researcher or the main research assistant, and that 12 students (18%) saw the study announcement on the university webpages (course i.e. LMS, faculty, Twitter, or Facebook).

In the second section, participants were asked to select all the reasons that motivated them to participate in the study from the list shown in Table 1. "To obtain the promised incentives" and "to help the cause of the researchers" were among the highest motivations across all participants regardless of gender. For student participants, "to grow in my coding skills" ranked very high for both genders, while "to help students in their coding skills" was an important motivation for more than half of the tutor participants.

Table 1. Reasons that motivated participation in the study with gender differences.

	Male	Female	Total
1. To obtain the promised incentives	36 (71%)	12 (75%)	48 (72%)
2. To help the cause of these researchers	35 (69%)	11 (69%)	46 (69%)
3. To know more about my coding skills (students)	23 (66%)	4 (31%)	27 (56%)
4. To grow in my coding skills (students)	29 (83%)	11 (85%)	40 (83%)
5. To experience this new role (tutors)	8 (50%)	1 (33%)	9 (47%)
6. To help students in their coding skills (tutors)	9 (56%)	1 (33%)	10 (53%)
7. Because of the good reputation of this research group	2 (4%)	0 (0%)	2 (3%)
8. Because of a positive experience in another research study	4 (8%)	1 (6%)	5 (7%)
9. Because I was encouraged/invited to do so	11 (22%)	3 (19%)	14 (21%)
10. Other	4 (8%)	1 (6%)	5 (7%)

Note: Reasons 3 and 4 were proposed to Students only (N=48; Male=35; Female=13); Reasons 5 and 6 were proposed to Tutors only (N=19; Male=16; Female=3); All other reasons were proposed to all 67 participants (Male=51; Female=16).

The third question asked participants to rate their satisfaction on a 5-point Likert scale from "Strongly disagree" (1) to "Strongly agree" (5) over different aspects regarding the study information and their informed consent, as well as on their satisfaction with the research staff. Table 2 indicates that on average, 91% of the 67 participants either agreed or strongly agreed with each statement. Except for the first statement, the means are higher than 4 (average mean = 4.51), which is between "agree" and "strongly agree". The internal consistency reliability for the data collected in this section has been estimated by computing the Cronbach's Alpha and McDonald's Omega, with 0.81 and 0.86 respectively, which indicate high reliability.

Table 2. Students' satisfaction of the research study experience.

	Mean	% Agree / Strongly agree
1. I found the study website easy to navigate	3.70	69%
2. I found the study information well explained	4.06	81%
3. I understood easily how to register to the study	4.60	100%
4. I understood the study procedures before providing my informed consent to participate	4.37	90%
5. The research staff answered all my questions	4.63	94%
6. I understood that participation was voluntary	4.88	100%
7. I understood that I could withdraw from the study anytime	4.79	99%
8. I understood the risk(s) involved with participating in the study	4.22	82%
9. I understood which of my data would be collected during the study	4.12	79%
10. I felt the research staff were approachable when I had questions or concerns	4.66	96%
11. I felt the research staff were easy to contact	4.70	96%
12. I felt the research staff were professional	4.79	97%
13. I felt the research staff were knowledgeable	4.70	94%
14. I felt the research staff were courteous	4.82	99%
15. I felt the research staff were sensitive to my concerns	4.54	91%
16. My overall experience was positive	4.55	96%

The last section surveyed the likelihood that participants would participate themselves or encourage others to participate in a future study by this research group. On a four-point Likert scale from "very unlikely" (1) to "very likely" (4), all 67 participants responded positively ("likely" and "very likely").

4 Discussion and Conclusion

Considering the estimated pool of potential participants (N=1000), the number of registrants (N=148), and the number of participants who completed the study (N=67), the participation rate for this study was 15% with an attrition of 55%, which is considerably lower than the common expectation of participation rates at 33% with attrition of 20% [3]. This surprisingly low participation rate is even more alarming given that several recommended recruitment strategies have been followed. The high degree of satisfaction of those who completed the study on a) study information, b) communications with the research contact person who was highly available throughout the study period, c) their overall experience, and d) their positive intent to participate or promote another study with this research group are indications that those aspects of the study are not to be blamed for the low participation rate. Yet, the satisfaction level of the participants who withdrew or dropped from the study was not captured, which should be done in future studies.

One main reason that might have contributed to this low participation rate is that this study was an additional load to students' normal course workload. To circumvent this downside in future studies of SLE conducted in postsecondary institutions, two alternatives may be considered. First, which is more on the long term and left to the executives of computer science faculty to consider and decide, is to create a different culture among students of their faculty similar to the one found in psychology programs where students are highly exposed to research studies and are expected to participate in research as part of their degree requirements, resulting in students viewing research as a normal part of their educational experience. A second alternative would be to adopt an observational study design rather than a controlled study design [9], where SLEs would be integrated in a course and students could voluntarily use it while accomplishing the assignments already required in that course. These proposed alternatives are preliminary and require further efforts and research to verify their efficacy.

This experience report highlights challenges faced by the research community in recruiting and retaining participants for research studies in postsecondary institutions where smart learning environments are looking to make significant inroads. Efficacy and future development of smart learning environments rely on authentic recruitment of research participants. The community will be well served if SLE researchers report their recruitment and retainment strategies, their success rates, and participant satisfaction. Altruism, intrinsic motivation and enticement are the predominant factors in participant recruitment. In addition, smart learning environments need to cultivate a level of trust to attract and retain potential participants.

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Constructing a Hybrid Automatic Q&A System Integrating Knowledge Graph and Information Retrieval Technologies

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Abstract. Question-answering (QA) system provides a friendly way for human-computer interaction, which has become an important research direction of smart learning. It provides an easy and individual way for the learner to acquire knowledge. This paper focuses on K-12 education and constructs a hybrid automatic question-answering system which integrates Knowledge Based Question Answering (KB-QA) and Information Retrieval-based Question Answering (IR-QA). The system is built based on Chinese textbooks and a Chinese K-12 knowledge graph (edukg.org). Our QA system covers 9 subjects in K-12 education field, including mathematics, Chinese, geography, history, etc. We evaluate our system on more than 9,000 questions, and achieve average accuracy over 70%. The system could provide effective assistance for teachers' teaching and students' learning.

Keywords: Smart Education. Knowledge Base. Question Answering

1 Introduction

Smart education [1] has attracted a large amount of attention in research. The essence of smart education is to build a smart learning environment with technology, where students can acquire knowledge and solve problems faster and better. The automatic question answering (QA) system is a very effective way which can help students get answers in a timely manner during the daily learning process. So far the existing QA systems are not designed for K-12 education. Therefore, the challenge is to build a question answering system specifically for K-12 education, which can accurately understand the students' questions and give precise answers quickly.

The early stage QA system [2] was a template-based expert system that was designed to manually construct rules for specific domains. The disadvantage is that it can only process a small amount of data in a specific field. With the search technique developing, the information retrieval question answering (IR-QA) [3]

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appeared. It extracts the answers in a large number of texts based on the keywords and semantic relationships, e.g., IBM Watson [4], TREC, etc. These QA systems solved the previous narrow coverage limitation to a certain extent, but due to the uneven quality of the text, the accuracy was unsatisfying at the same time, the Internet QA community gradually emerged such as Yahoo Answers, Stack Overflow, etc. These QA communities only provide an aggregation platform for users, the correctness of the answers depend on the user's own judgment.

"Knowledge Graph" [5] was proposed by Google to define the structure of knowledge from a new perspective. It attempts to transform unstructured data into structured data from the data itself and connect the various data together to form a graph model. This structured graph data provides a new direction for the development of the question answering system, namely the knowledge graph based question answering system (KB-QA), which can provide users with the structural data in the knowledge base. Since KB-QA can provide very simple and precise answers, it gradually becomes an important research direction of the question answering system. KB-QA can also effectively help with the development of "next generation intelligent retrieval" and "humanoid robot".

The core idea of KB-QA is to semantically analyze the question statement and transform it into a structured query language, then get the final answer by querying and reasoning the knowledge graph. Berant J [6] uses semantic analysis methods, such as Combination Category Grammar (CCG) and Dependent Combination Semantics (DCS) [7,8,9] to directly obtain the semantic representation of the question to query the knowledge base, and then get the answer. These semantic parsing methods are not good for questions containing multiple instances and multiple relationships, which limits the system's performance. Bast H [10] classifies questions according to the number of entities involved in the question, and formulates three corresponding templates, and then queries the knowledge graph to get the answer. The advantage of this method is that it has a certain reasoning ability from the question. Given multiple entities, it is easy to find the common relationships and nodes between the entities. However, this requires the connectivity and data quality of the knowledge graph to be very high.

So far, the main challenges of KB-QA are as follows: 1. the semantic analysis caused by the diversity of natural language problem is difficult. For example, "Who is the author of Hamlet?" and "Who wrote Hamlet?" have the same meaning. 2. The accuracy of entity recognition in the domain affects the accuracy of KB-QA. However, KB-QA has the advantage of high precision, while the recall is fairly low.

The IR-QA system depends on a reliable retrieval strategy. Its core technology is information extraction and matching. IR-QA contains three steps normally. 1. Extract keywords from the question. 2. Retrieve relevant documents from the corpus. 3. Filter requested information from the documents. The advantage of IR-QA is that it can retrieve the relevant documents that most likely contain the answer. The recall of IR-QA is fairly high, while the precision is fairly low.

This paper proposed a hybrid question answering system in the K-12 education that combines KB-QA and IR-QA [11, 12], taking advantages of both. We focus on the factoid questions which can be directly answered by one entity or one property in the knowledge graph. For example, “Where is Stephen Zweig from?”, we can get the answer, “Germany”. Our contributions in this paper can be summarized as follows:

- Proposed an automated question answering system which can efficiently answer questions in the K-12 education field.
- Combine KB-QA with IR-QA to improve the accuracy and coverage of answers.
- Full coverage of 9 subjects in the field of K-12 education, including Chinese, math, English, history, geography, biology, physics, chemistry, politics.

2 Related Works

Recent years, the question answering system has made great progress in the field of smart education. A wide variety of systems and related hardware devices are emerging. The emergence of early education robots and smart speakers provides a new way for children to learn knowledge through entertainment; exam answering robots are constantly challenging the limits of human examinations. These robots or applications are inseparable from a QA system that supports them in the background. The robots and AI devices based on automatic QA have effectively supplemented the traditional one-to-many education model that has not been overcome in the field of smart education, and opened up a one-to-one education model for human-computer interaction.

At the heart of IBM’s Watson robot [4] is an automated question answering system based on machine learning. The robot has already defeated human players in the television quiz show “Jeopardy!” In the field of smart education, IBM launched the Watson Education Classroom to provide intelligent solutions for teachers and students.

In China, the AI-MATHS [13] and Aidam [13] robot challenged the Chinese college entrance examination and scored 105 points and 134 points in the mathematics volume (out of 150); Todai Robot [14] from the University of Tokyo in Japan has been able to pass the local university entrance examination, and exceeded the average score in subjects such as mathematics, physics, and English.

In recent years, Deep Learning (DL) is rapidly developing. Many researchers try to build KB-QA system using deep learning model. Dong [25] used a convolutional neural networks (CNN) to understand the question. Ming [26] structured an end-to-end KB-QA model based on a Long Short-Term Memory (LSTM) model. Salman [27] focused on the factoid question and divided the task into entity detection, entity linking and relation prediction, on this basis they build an LSTM+RNN model. These models get better results than the traditional methods, but they are lack of interpretation and controllability.

Yet all these methods are not focused on factoid question answering for K-12 education. But these questions’ relevant knowledge is important for K-12 students, while we combined the advantages of KB-QA and IR-QA and tried to build a hybrid factoid question answering in K-12 education.

3 System Structure

In this section, we will introduce the structure of our automatic question answering system. For QA system in K-12 education [15] field, accuracy is the most important prerequisite. The system integrates template matching [16], similarity calculation [17] and text retrieval [18], it tries to cover as many concepts as possible in each subject. We developed the QA system in Java and deployed it on a Tomcat server. The query language that we search knowledge graph is SPARQL. The architecture of the system is shown in Figure 1.

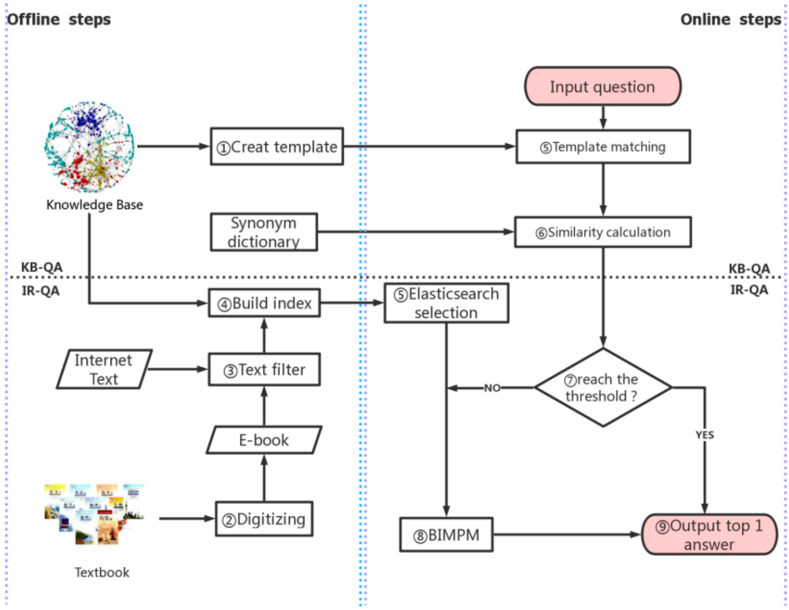

Fig. 1. The Question Answering System Structure

3.1 Offline Steps

In offline steps, we formulate the feature rules of questions manually, and generate templates by the computer automatically. A number of high-quality question templates for K-12 education are constructed as the basis of the KB-QA module. We digitized more than 1,300 physical textbooks, and acquired more than 10,000 electronic books from digital libraries. Also, we filter and clean the amount of text data on Internet. Then we got a large amount of high-quality text data, these data can be used for the IR-QA module.

Templates are very important for the whole system. They have a certain influence on entity and predicate recognition. Therefore, how to construct a high-quality template generation system is very important. In our system, the templates are constructed using regular expressions. Each template has a plurality of fields, such as attributes and priorities, corresponding to the specific regular expression template, e.g., "(?<title>(.*)?)作者(.*)?". The Chinese word "作者" means "author" in English. This template is to search the author of a book or an article. A detailed look of the template's regular expression is shown in Table 1.

Table 1. Structure of the templates

Field	Example	Type
content	(?<title>(.*)?)地理位置(.*)?	varchar(200)
subject	true	tinyint
value	false	tinyint
type	diliweizhi	varchar(100)
class	null	varchar(50)
usage	data	varchar(20)
priority	1	int

- **Content**: The content row is the template content which is written in regular expressions. For example, if the question matches the template, it will recognize "地理位置" as a possible predicate of a question, while the Chinese word"地理位置" means "geographical location". "(?<title>(.*)?)" is a named group capture that was used to determine the location of the subject. For example, "Where is the geographical location of Mount Tai", the template got the subject is "Mount Tai".
- **Subject/Value/Type:** This field indicates whether the template subject is determined, the default flag is true. If the subject of the question is unknown, it will be marked as false. Such as "who is called Tian Khan", "value" indicates whether the object is certain or not, "type" indicates the label of the template.
- **Class**: It indicates the class of the subject, it was used to qualify the subject of certain special questions and can be ignored.
- **Usage**: When questions can't be answered through a simple SPARQL query, "usage" is used to identify these questions. It is optional.
- **Priority:** This field indicates the priority of the template. It is mainly used to calculate the score of the predicate.

3.2 Online Steps

The answering process of the problem is completed by KB-QA and IR-QA. The implementation of each part will be introduced separately below.

KB-QA. KB-QA includes the following five sub-modules:

- **Entity recognition [19] and entity linking [20] module:** In this module, we adopt template segmentation, synonym word forest query, similarity calculation, longest common substring matching, etc., and set the priority according to the confidence of each method. Then we build a set of candidate entities.
- **Predicate and relationship identification module:** This module uses template matching, similarity calculation, etc. The method also sets the priority according to the method to obtain a set of candidate Predicate.
- **Query statement generation and query module** [21]**:** According to the candidate sets, this module generates a SPARQL [22] query statement, and query the corresponding result from the knowledge base, then add to the candidate answer set. For example, "Who is the author of Hamlet?", the subject is "Hamlet" and the predicate is "author". We get a SPARQL query statement like this:

```
SELECT distinct ?subject ?author
from<http://edukb.org/Chinese>
WHERE {
?subject rdfs:label ' Hamlet '.
?property rdfs:label 'author'.
?subject ?property ?author.
}
```

- **Answer screening module:** According to the priority of the entity and the predicate, we calculate the score of each candidate answer. Then, we choose the top1 as the answer.

IR-QA. IR-QA will be used when KB-QA cannot provide a credible answer. We will select a text sentence from the text corpus. IR-QA is composed of the following two parts:

- **ElasticSearch [18] rough selection:** (1) We use the rules to special treatment of the question, find the most advanced key such as "highest", "third" and other words. (2) Splitting the question into words, and assigning different vocabulary weights according to the established part of speech priority. (3) Using the combined query and similarity matching strategy to query the selected keywords.
- **BiMPM [23] Featured:** Use the BIMPM model to further screen ElasticSearch's rough selection results, then choose the top1 answer.

4 Experiments

The system is an automatic QA system based on the K-12 education knowledge base and a large number of electronic texts. The K-12 education knowledge base [24] contains more than 22 million triples, 1.62 million instances, 1,000 concepts, and 4,000 attributes. The source of knowledge includes the annotation library and the external source library. The annotation library is obtained from the knowledge which is tagged in the textbook, the external source library is extracted from the encyclopedia and Internet data. These textbooks are provided by The National Library of China for research. It covers all knowledge points of the 9 subjects in K-12 education. The electronic text mainly includes 1,300 elementary education textbooks and 10,011 electronic extracurricular reading materials.

4.1 Test Dataset Generation

In the preliminary preparation work, a great number of test questions was obtained from the teacher resource books, the Internet and the textbooks. All of these questions have exact answers. The questions types mainly are fill-in-the-blank questions, multiple-choice questions, reading comprehension questions, essay questions, etc. These questions cannot be directly parsed by the KB-QA system. So we need to convert them to the questions that our system can analyze. For example, "The ratio of land to sea in the world is about ( )" is converted to "What is the ratio of land to sea in the world?".

Accuracy is the main evaluation index. We test each subject's question dataset separately. When we input the test cases, answers are recorded. The test cases are designed for each subject. The subjects include Chinese, math, English, physics, chemistry, history, geography, biology, and politics. A total of 9,020 test cases were written by experts. The details of the questions in each subject are shown in Table 2.

Table 2. Quantity of test cases under each subject

Subject	Number of test cases	Percent of all test cases (%)
Chinese	1,007	11%
math	926	10%
English	1,033	12%
physics	1,000	11%
chemistry	1,001	11%
history	1,040	12%
geography	1,017	11%
biology	1,000	11%
Politics	996	11%
Total	**9,020**	**100%**

4.2 Experimental Result

Totally 9,020 test cases were executed, and the result of each test case was recorded in detail. Test case execution statistics and results are shown in Table 3 and Table 4. Table 3 shows the accuracy of each subject. Mathematics got the highest accuracy, because most of its subject knowledge are described precisely. Geography got the lowest accuracy, because a variety of geographical questions need to ratiocinate or summarize the answer from attribute value or text data. For example, "What does crustal movement lead to?". The expansion of the knowledge graph and text data is helpful to increase the accuracy.

Table 3. Accuracy of Our system on test cases

Subject	Number of test cases	Correct	Wrong	Accuracy(%)
Chinese	1,007	787	220	78.15%
math	926	862	64	93.09%
English	1,033	887	146	85.87%
physics	1,000	911	89	88.40%
chemistry	1,001	897	104	89.61%
history	1,040	904	136	83.17%
geography	1,017	739	278	72.66%
biology	1,000	860	140	85.50%
politics	996	885	111	88.86%
Total	**9,020**	**7,732**	**1,288**	**85.72%**

Table 4. Example test cases

No	Subject Question	Answer
1	**Chinese**	
1.1	Who is the author of "Shi Ji"	Sima Qian
1.2	What are the elements of the message?	Person, time, place, cause, event
1.3	Where is Stephen Zweig from?	Germany
2	**Physics**	
2.1	How to calculate the active power?	P=W/t
2.2	What is the function of infrared ray?	heat energy
2.3	What is the applied object of gravity?	earth
3	**Geography**	
3.1	What temperature zone is Europe in?	North Cold Zone, North Temperate Zone
3.2	What's the climate in eastern China?	monsoon climate
3.3	What are the three elements of a map?	Scale, direction, legend

5 Conclusion

With the advancement of artificial intelligence, smart education is developing towards intelligence and individualization. The question answering system is a new hotspot in this field. We construct an automatic question answering system that integrates KB-QA and IR-QA, combines traditional template matching with semantic calculation, and achieves fairly good accuracy. The system can help many primary and middle school students who lack counseling resources, they can get answers in a timely manner during their daily study. At the same time, it can be integrated with various educational hardware or mobile applications to improve their ability to provide automatic QA for students. It has positive significance to construct the smart education system in the Internet era.

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Conversation Quest in MEGA World (Multiplayer Educational Game for All)

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Abstract. The research team has developed a web-based massively multiplayer educational game platform named MEGA World. It allows teachers to create their own virtual worlds and to design a series of learning and assessment activities (i.e., quests and quest chain in a commercial game) for their students. The platform is also a multilingual platform that supports any languages and makes teachers capable of accessing external resources (e.g., multimedia, materials, online meetings, etc.). Students can learn and reach the predefined learning goals by taking and solving the quests while playing. Seven types of quests have been provided for teachers, including greeting, item collection and delivery, sorting, treasure hunting and digging, calculation, fill-in-the-blank, and short answer quest types. The research team is further design and develop conversation quest activities for Foreign English Learners (EFLs) to practice their speaking skills. While people believe that learners' communicating skills can be improved by using a language to interact with native speakers, in many cases to have a native speaker practicing with the learners is not an available or an affordable option for them. This paper mainly focuses on how the teachers can build a place that provide simulated conversation scenarios within a no-pressure environment via the creation of conversation quests and the use of MEGA World.

Keywords: educational game, multiplayer, language learning, English, stealth assessment

1 Introduction

Speaking is considered the riskiest one that may cause embarrassment or humiliation for language learners [3]. Some learners may not realize how difficult speaking is until they need to use the language in the real world situations. For reasons make learners anxious while speaking in real world: (1) the reaction time is too short to prepare and plan what you want to say; (2) you cannot change or "rewrite" the words you have said; (3) you don't have time to "google" or search for phrase or words that are more closely to what you want to say; and, (4), you don't have time to organize your thoughts. It would be always better if the opportunity of speaking a foreign language to native speakers or speakers who are at advanced level of the particular lan-

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guage. However such option sometimes may not easy to find or afford by every learners.

In the most of multiplayer or massively multiplayer online games, it is very common to see players to “talk” to other players for arranging tasks and communicating tactics. These games increase the opportunity for learners speaking to other players whose first language is English and practicing their speaking sill. However, this type of random conversations may have some drawbacks; for instances, (1) the learners may speak to players whose first language is also not English and may learn the language not so correctly; (2) the terminologies used in the communications happened in the games may not really useful in the real world situations; and (3) misunderstanding the real usage of certain words or phrases, and overuse the abbreviations.

Taking a common term used in the games, “GG”, as example. For native English speakers, “GG” is for “Good Game,” which is what people always say just right after a basketball game or a competitive event to show good sportsmanship. In Taiwan, the meaning of “GG” has been treated as “game over” since people always see it at the end of a competition or match in a game. That makes people start to say, “I am GG!” when they actually want to express their feeling of “I am doomed!”

In order to avoid the above-mentioned drawbacks while still giving learners opportunities to practice their speaking skill in a no-pressure environment (i.e., a game), the research team proposes and develops a new “Conversation” quest type and adds it into MEGA World [2][4].

The paper is organized in the following way. Section 2 first briefly introduces MEGA World. Sections 3 and 4 use cases and screenshots to explain how teachers can add a conversation quest to the game world for their learners to take and practice. Section 5 makes conclusion and talks about the evaluation plan.

2 MEGA World (Multiplayer Educational Game for All)

Both of Role Playing Games (RPGs) and Computer Assisted Language Learning (CALL) use tasks with specific goals as a key element to engage players and learners working on the game-play and learning process. This key element is called Quest-Based Contextualization Process (QBCP) in RPGs and it is called Task-Based Learning (TBL) in CALL [5].

The research team has designed a multiplayer online role-play game (MORPG), called MEGA World (MEGA stood for Multiplayer Educational Game for Assessment in v1.0 back to 2010 and now stands for Multiplayer Educational Game for All), which uses quests to assess students’ knowledge of programming languages learned from the courses [1]. The game world is chessboard like, and students can travel in the world from one cell to another. Some cells on the chessboard are villages. Students can go into the villages to buy foods, meet other players and Non-Player Characters (NPCs).

As Fig. 1 shows, a student appears at a cell (annotated as #1 in Fig. 1) after he or she signs in. The surrounding eight cells (annotated as #2 in Fig. 1) of the current location are the positions that he or she might move to. The student can click on one of the surrounding cells to move to it. Each move will cost his or her energy as annotated #3 in Fig. 1, and he or her needs to consume foods to gain more energy. When he or she goes into a village (annotated as #4 in Fig. 1), he or she can visit a food store to buy foods to stock (annotated as #5 in Fig. 1). Some NPCs can be found in the houses and work areas and they sometimes have quests for students to pick-up.

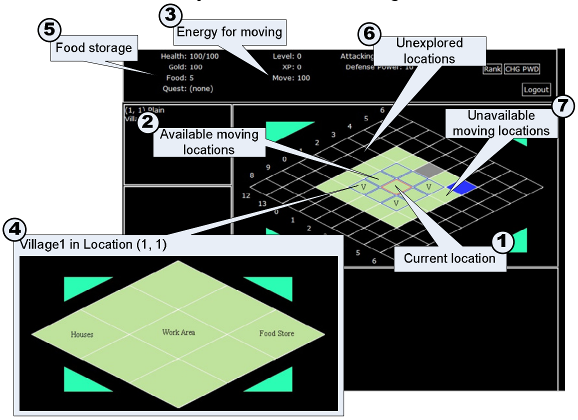

Fig. 1 The original MEGA World (v1.0) in 2010.

The current version of MEGA World[1] (Multiplayer Educational Game for All) is v2.1 and supports seven quest types for teachers to create: greeting, item collection and delivery, sorting, treasure hunting and digging, calculation, fill-in-the-blank, and short answer quest type [4]. In this version of the game, students can have their own avatars and see others visually. MEGA World aims to offer students a game that they can learn and be assessed while playing (see Fig. 2).

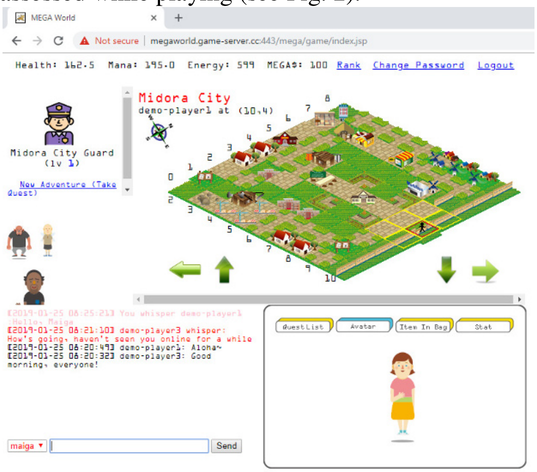

Fig. 2 MEGA World v2.1.

[1] http://megaworld.gameresearch.ca

3 Conversation Quest Creation

For having a practical and meaningful conversation, the research team works with professional English instructors and provides them a conversation tree editor so they can easily (co-)create conversations for various topics like Restaurant, Lodging, and Transportation. Fig. shows an example of the conversation tree related to book a room at hotel. More details for the conversation tree editor can be found in [2].

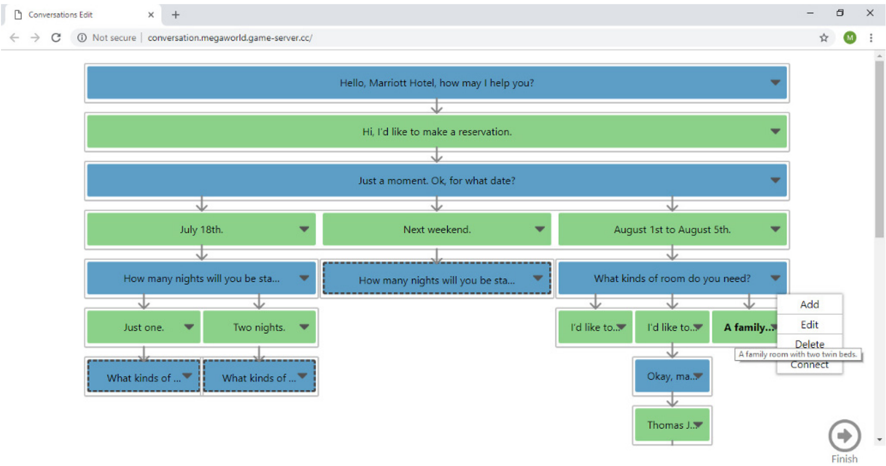

Fig. 3 Conversation Tree Example for Booking a Room at Hotel.

As soon as the conversation trees are pre-defined and designed by teachers, teachers can use the management system to create a conversation quest and associate it to a conversation tree like Fig. 4 shows.

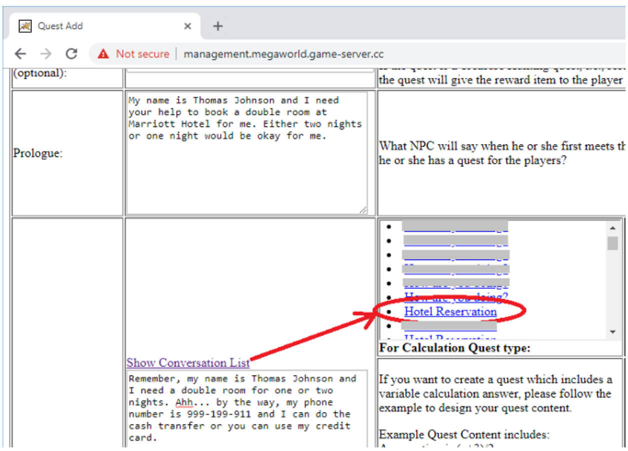

Fig. 4 Create a Conversation Quest by Selecting Predefined Conversation Tree

4 Solving a Conversation Quest

Learners in MEGA World can see some NPCs that have requests for them to help and solve. Fig. 5 shows that the NPC Guard "Thomas Johnson" in Midora City has a "Hotel Reservation" conversation quest that pre-created by the teacher. If the learner wants to take the quest and help the Guard, he or she can pick it up and then click the START link.

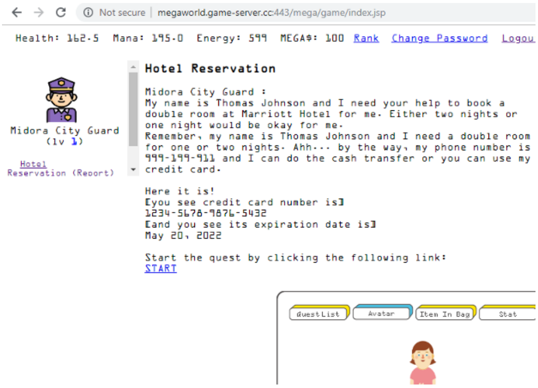

Fig. 5 Create a Conversation Quest by Selecting Predefined Conversation Tree

As Fig. 6 shows the learner needs to "speak" to the hotel staff with appropriate responses. The staff (i.e., computer) will try to get what the learner says with Google's Speech-to-Text API's help and then map to the predefined conversation tree to see what should it ask and talk for next. When the conversation ends, the learner will be redirected back to the NPC Guard and collects his or her rewards according to his or her performance of "speaking" and "communicating" to the hotel staff.

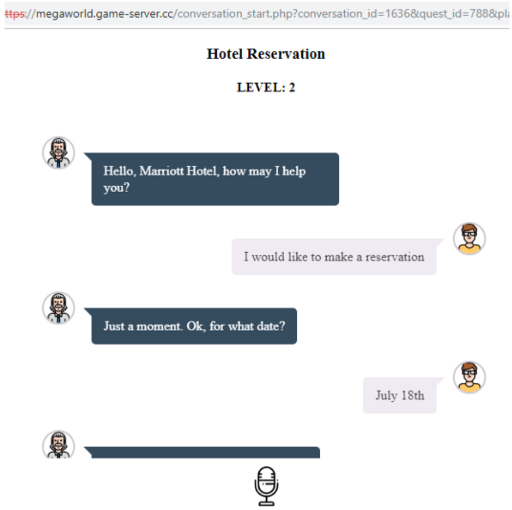

Fig. 6 Learner helps NPC "Thomas Johnson" book a room by "**speaking**"

5 Conclusion

In order to evaluate the effectiveness and usability of the conversation quests, the research team would like to conduct a quasi-experiment with English as a foreign language (EFL) teachers and learners. The conversation tree editor will be introduced to the teachers and a brief demographic questionnaire regarding learners' computer assisted language learning (CALL) experience will be distributed for the learners.

The research team will work with teachers and help them become capable of creating conversation trees, for different exercises in their courses, on their own. During the semester, learners are encouraged to play the game and solve conversation quests as frequently and as many as possible, or at least once per week. Learners' English speaking skills related with the pre-defined conversation trees will be assessed by the teachers at the end of the experiment. Moreover, another questionnaire will be given to the learners to investigate their perceptions toward the conversation quests.

Besides the data collected via questionnaires, the in-game data like the frequency of playing the game and solving conversation quests, the conversation quests took and solved, and the rewards (e.g., experience points) earned during the experiment can be analyzed and compared with learners' final oral exam scores and survey results. For instance, learners who received more rewards averagely for solving conversation quests may indicate that they have higher mastery level in terms of speaking. We also expect to see learners who are taking and solving conversation quests much often may have more improvements on their speaking skills. Last but not the least, we may be able to find out what kinds of conversations that learners may be scared from picking up and speaking due to they don't know how to speak aloud their thoughts in English.

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Correlational Analysis of IRS Features and Learning Performance in Synchronous Sessions of an Online Course

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Abstract. This paper investigated the relationships between students' perceptions toward the features (i.e., feedback, engagement, usability, and satisfaction) of two instant response systems (IRS) and their learning performance in the synchronous sessions of an online course. A survey was conducted for assessing how IRS features are related to learning performance. Two different IRS tools, "Kahoot" and "mQlicker," were used to conduct meaningful interactive learning activities in the synchronous sessions of an online course. Collected data were analyzed using Pearson Correlation analysis, and it was found that students' feedback, usability and satisfaction are significantly correlated to learning performance. On the other hand, engagement did not show any significant correlation to learning performance. Discussion and implications of adopting IRS tools are also presented.

Keywords: Instant response system (IRS); Feedback; Engagement; Usability; Learning satisfaction; Learning performance.

1 Introduction

Instant response systems (IRS) are becoming increasingly popular for better receiving students' feedback, both in physical and online classrooms. Besides, the value of IRS in the pedagogical sector has gained increasing attention as a way of enhancing learning [1]. There could be numerous reasons for educators to use an IRS tool in the classroom. For example, it can be used for providing immediate feedback [2] about a particular topic of interest, creating a cumulative record of participation [2], enabling widespread anonymous participation [3], enhancing engagement among students, teachers [4] and content [3]. Chien, Chang, and Chang [3] mentioned that engaging students in explaining and justifying their answers to IRS questions is highly recommended because such an instructional strategy is associated with positive and strong effect sizes for academic learning outcomes. Therefore,

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teachers are mainly focused on the term “instant responses” when implementing IRS-integrated instruction in their courses. Due to its learner-friendly interface, an IRS has a comparative advantages over conventional learning systems with the similar cognitive aspects of learning practices [5]. For example, Oigara and Keengwe [4] found that the superior effect of IRS-integrated instruction, compared to conventional lectures. In another study, Dong, Hwang, Shadiev, and Chen [6] found that introverted students are quiet, less active, and tend to be withdrawn from others [7]. As commonly known that extroverts and introverts correspond to active and reflective students; Dong et al. [6] found that students with introverted characteristics like to participate in IRS-based courses. Some research focuses on the relationship between IRS use and student learning that examines the relationship between IRS use and student learning performance in traditional classrooms. There is a lack of research on exploring the relationship between students’ perceived IRS features and learning performance in synchronous sessions of an online course. The aim of this study was to fill this gap by analyzing the relation between different IRS features, including feedback, engagement, satisfaction, and usability, and students’ learning performance in synchronous sessions of an online course. Two popular IRS tools “Kahoot” and “mQlicker” were chosen to conduct IRS-based instructions in the experiment. The research questions are stated as follows:

1. What are the relationships between students’ perceived IRS features and learning performance in the synchronous sessions of an online course.

2 Literature review

2.1 Pedagogical applications of IRS tool features and learning performance

A number of recent works have identified that the perceived IRS tool features (i.e., feedback, engagement, usability, learning satisfaction) are important factors for effective learning (1). Hunsu, Adesope, and Bayly [8] found that IRS questions improved memory of material two days later compared to no-IRS controls, provided that immediate feedback was given for each question. Thus, instant feedback is one of the major features of IRS that is defined “as the degree to which teachers providing instant responses with visual representation improves the students’ understanding of the content, sharing of opinions, etc.” [9]. Engagement is another important IRS factors which is determined by the interactions between the environment and the individual, so that social and academic changes in class modify students' perceptions and engagement [10]. This study defined engagement as the perception of the student that results from his/her relationship with teachers, peers, and learning activities with IRS tools during the learning experience, and which generates involvement with the topic studied [9]. A perceived usability factor was defined by Shackel and Richardson [10] as “the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfill the specified range of tasks, within the specified range of environmental scenarios.” In this study, usability refers to an IRS tool which can be used easily and effectively by the distributed participants with existing skills, to fulfill the specific range of tasks [9]. Oliver [11] stated that "satisfaction is the consumer's fulfillment responses. It is a judgement that a product/service feature, or the product or service itself, provided (or is providing) a pleasurable level of consumption related fulfillment, including levels of under- or over-fulfillment" (p. 8). In this study, we define satisfaction as the students' responses as a judgement of the IRS features, their usage that provides a pleasurable level of learning-related fulfillment, including levels of under- or over-fulfillment [9]. Both students and faculty have reported that the experience of using IRSs in the classroom is very positive and leads to increased classroom satisfaction [12].

3 The tool features of Kahoot and mQlicker and learning task designs

There are six reasons to use Kahoot as an IRS tool, namely it is flexible, simple to use, diverse, engaging, global, and free to use. People choose Kahoot according to the demands of their profession. Kahoot provides four key features of quiz, survey, discussion, and Jumble. Surveys can be used to find out what participants already know (or have just learned without competition). The discussion feature is provided to get educators through building the questions and hosting them quickly. Kahoot allows 95 characters for questions and 60 characters for answers, and also allows users to add media supports such as images, videos, PPT, etc. Moreover, another tool, mQlicker, can also be used as an IRS tool. There are many reasons to use mQlicker: it provides WYSIWYG editing of interactions and questions dragging and dropping between most parts of the administrative user interface, powerful search features, and a question bank for easy re-use. Moreover, mQlicker provides templating support, previews while editing questions in interactions and a user-defined folder structure for organizing data.

4 Methods

4.1 Participants, instruments and procedure

The participants were master's students of a university in Taiwan. A total of 26 students aged 23 to 28 years old participated in this study. A 10-item questionnaire was developed to survey the students' perceptions about the different IRS features in assisting their learning as shown in the Table1. Each item was rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The experiment was conducted over a period of eight online synchronous sessions, with a total of 400 minutes. The procedure of this study consisted of three steps. In the first step, participants were given brief instructions on how to log into Kahoot and mQlicker and on how to participate in the learning activity sessions. In the second step, each participant was asked to participate the designed learning activities using different IRS features for eight sessions. The third step was to fill the questionnaire for approximately 15 minutes.

Table 1. Descriptive statistics and factor loading

Description of items	Mean	Stdv	FL
Feedback (Standardized Cronbach's α=.680)			
F1: The instant feedback (i.e., the results provided by IRS based on all inputs from students) and visual representation of summarized results was helpful for my understanding of the content	4.55	.751	.945
F2: The instant feedback (i.e., the results provided by IRS based on all inputs from students) was useful for me to clarify my misconception even when I made mistakes	4.40	.843	.895
F3: I acquired some new knowledge from the analyzed results of instant feedback provided by IRS based on all input from students	4.44	.891	.694
Engagement (Standardized Cronbach's α=.55)			
E1: The use of IRS in this course helped me engage more in classroom learning	4.40	.690	.853
E2: I actively participated in the learning activities facilitated by IRS	4.40	.600	.853
Usability (Standardized Cronbach's α=.775)			
U1: . IRS is a user-friendly IRS tool	4.33	.919	.794
U2: I found IRS in this course easy to use	4.03	.979	.855
U3: It would be easy for me to become good at using IRS in the classroom	4.48	.642	.700
U4: IRS provided excellent visualization of the result	4.44	.751	.782
Satisfaction (Standardized Cronbach's α=.864)			
S1: I am satisfied with using Kahoot as a learning/instructing assisted tool.	4.14	.863	.902
S2: I felt comfortable asking questions during class about material I did not understand.	4.25	.764	.842
S3: I found the use of Kahoot in the course to be fun.	4.40	.693	.815
S4: I'm satisfied with the accuracy and the quality of the output.	4.48	.642	.762

5 Results and discussions

5.1 The relationship between students' perceived IRS features and learning performance in the synchronous sessions of an online course.

A Pearson correlation analysis was used, with the measure of the relationship between students' perceived IRS features and learning performance in the synchronous sessions of an online course. The result of the Pearson correlation analysis is presented in Table 2

Table 2. Correlation between perceived IRS features and learning performance (N=26)

	Perceived IRS feedback	Perceived IRS usability	Perceived IRS satisfaction	Perceived IRS engagement	Learning performance
Perceived IRS feed back	1	___			.572**
Perceived IRS usability		1	___		.537**
Perceived IRS satisfaction			1	___	.447**
Perceived IRS engagement				1	.212

**Correlation is significant at the .01 level (2-tailed)

It was found that the relationship between perceived IRS feedback, usability and satisfaction features and learning performance was significant, $p < .05$. The results show that perceived IRS feedback, suability and satisfaction features were respectively significantly correlated with learning performance ($r=.572$, $p=.002$; $r=.537$, $p=.004$; $r=.447$, $p=.019$). More specifically, the higher the feedback, usability and satisfaction, the better the learning performance. While some studies have found that IRS use in the classroom correlates with higher test scores, other studies found no such effect [13]. Students might apply IRS during their assigned individual/group PowerPoint presentation. For example, after presenting some slides, students might add one to two questions to ask the audience. Thus, it might enhance peer discussions as well as catching students' attention. Thus, the presenter/group might take challenge for their own task. Experienced IRS teachers might discuss the usefulness of IRS with their colleagues.The results also found that the relationship between perceived IRS engagement feature and learning performance was not significant, $p>.05$. The results show that perceived IRS engagement feature was not significantly correlated with learning performance ($r=.212$, $p=.288$). The finding of this study is very different from that of the study of Quaye and Harper [14], which found that student "engagement" is considered the best predictor of student learning and academic success. The reason might be that students are using many social media such as Facebook, Twitter, WeChat, Skype, etc. Such social media have many features that students use, which help them to be engaged seamlessly at any time. Thus, students are more likely to engage in social media rather than in IRS for learning.

6 CONCLUSIONS

This study explored the relationship between the IRS tool features and learning performance for students participating IRS-based learning activities in synchronous sessions of an online course. The results of this study indicate that the IRS tool features play a significant role in relation to the students' learning performance. It was found that feedback, usability and satisfaction were strongly correlated to learning performance. Moreover, the relationship between engagement and learning performance was not significant in this study. Future studies should consider adequate strategies for supporting teachers in designing effective IRS-based learning activities. For example, both formal and informal feedback from the students are important in order to enhance learning satisfaction, and more engagement may enhance students' expected feedback.

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Creating Smart Learning Environments with Virtual Worlds

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Abstract. A virtual world is an immersive 3D online environment whose residents are represented by avatars that move through the spaces and interact with other users and objects synchronously or asynchronously. The literature reveals that virtual worlds have significant potential to foster constructivist learning and create smart learning environments that are effective, efficient, scalable, engaging, flexible, adaptive, and personalized. This paper presents seven ways to use virtual worlds to create smart learning environments: (1) visualization of inaccessible and invisible content, (2) role-playing and identity exploration, (3) situated learning, (4) safe and adaptive environments for skill practice, (5) spatial simulation and virtual field trips, (6) social interactions and collaboration, and (7) virtual performance assessments.

Keywords: smart learning environments · virtual worlds · personalized learning

1 Smart Learning Environments (SLE)

The concepts of smart classroom and smart learning environment emerged in an effort to make learning environments more effective, efficient, and engaging. As an emerging field, smart learning environments (SLE) have been defined differently by different researchers. For example, Koper defined SLE as "physical environments that are enriched with digital, context-aware and adaptive devices, to promote better and faster learning" [1]. Hwang defined SLE as the "technology-supported learning environments that make adaptations and provide appropriate support (e.g., guidance, feedback, hints or tools) in the right places and at the right time based on individual learners' needs, which might be determined via analyzing their learning behaviors, performance and the online and real-world contexts in which they are situated" [2]. An increasing number of research studies have examined smart classroom and smart learning environments. However, most studies have focused on technology aspects (e.g., use of mobile devices), and the pedagogical aspect has not received sufficient attention [3].

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2 Virtual Worlds

A virtual world is an immersive 3D online environment whose residents are represented by avatars that move through the spaces (e.g., walk, run, fly, teleport) and interact with other users and objects synchronously or asynchronously [4, 5, 6]. Providing a sense of being there, virtual worlds provide new learning experiences. Many universities and researchers have been exploring various educational benefits of virtual worlds. Examples of virtual worlds designed for learning include *River City*, *EcoMUVE*, *Quest Atlantis*, *SimSchool*, and *Whyville*. The literature reveals that virtual worlds have significant potential to foster constructivist learning [5] and create smart learning environments that are effective, efficient, scalable, engaging, flexible, adaptive, and personalized.

3 Using Virtual Worlds to Create Smart Learning Environments

3.1 Visualization of Inaccessible and Invisible Content

Virtual worlds can make learning more effective and engaging by allowing students to observe things that they cannot see in classroom or other traditional learning environments. In virtual worlds, it is possible to show students the phenomena that cannot be observed in real time (e.g., climate change, erosion) or are invisible to the naked eye (e.g., the movement of molecules). It is also possible to create inaccessible content that is historically lost, imaginary, futuristic, or too expensive to reproduce in real life [6]. The visualization of inaccessible or invisible content offers new learning opportunities and fosters deep understanding.

3.2 Role-Playing and Identity Exploration

Role-playing is one of the most powerful engagement strategies. In virtual worlds, students experience new worlds and new identities by taking on roles otherwise inaccessible to them. They become heroes, scientists, doctors, and other experts and do important and meaningful things (e.g., solving a problem, saving others). The identity exploration through the virtual embodiment in the form of an avatar enables students to experience different situations, lives, and perspectives [6, 7]. Thus, virtual worlds have the potential to help students understand diverse perspectives and develop empathy.

3.3 Situated Learning

Virtual worlds can provide alternative environments for situated learning [8, 9] because a variety of real-world contexts can be created in the virtual space. Virtual worlds can make situated learning more effective by allowing students to learn at their own pace and by providing personalized and timely feedback. In addition, virtual worlds can expose students to a wide range of scenarios, enable students to explore alternative perspectives, help them develop greater cognitive flexibility, and improve transfer of knowledge and skills to real situations [10, 11].

3.4 Safe and Adaptive Environments for Skill Practice

It is often impossible or very expensive to provide students with sufficient practice opportunities in real life. Virtual worlds can provide a safe environment for students to practice a variety of skills, including taking off and landing a plane or administering medications to patients. In virtual worlds, students can practice with repetitive tasks at a time and pace convenient to them without real-world consequences. In medical simulations, for example, students can practice clinical decision making repetitively at no cost and without fear of harming patients [12]. They can take risks, try alternative strategies, and learn from mistakes.

3.5 Spatial Simulation and Virtual Field Trips

A variety of real-life places, including historical sites and museums, have been recreated in virtual worlds. Spatial simulation is one of the fundamental features of virtual worlds [13], and it can be used to create virtual field trips that are interactive and engaging. Many students do not have the opportunity to travel the world, and schools often do not have enough resources to provide many field trip opportunities. Virtual field trips remove many of the barriers (e.g., lack of funding, logistical challenges, physical limitations) and can take students to many different places and provide rich learning experiences.

3.6 Social Interactions and Collaboration

Many virtual worlds provide opportunities for social interactions and collaboration between individuals and communities, as well as interactions with objects and characters in the virtual space [6, 7]. Avatars can communicate nonverbally using gestures and postures, as well as verbally through the use of text-based chat, voice chat, and other communication tools. If designed and used effectively, virtual worlds can provide rich environments for collaborative learning.

3.7 Virtual Performance Assessments

In virtual worlds, students leave "information trails" [14] as they move through the virtual space and interact with objects and other characters or peers. Therefore, virtual worlds provide new vehicles for rich observations of student learning and performance and sophisticated analysis of complex performance that is impossible to assess in paper-based or other traditional assessment formats [15]. In addition, virtual performance assessments can be cost-effective because everything will be inside the virtual environment. It is unnecessary to purchase expensive equipment or materials needed for performance assessments in real life.

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Cultural Embodiment in Virtual Reality Education and Training: A Reflection on Representation of Diversity

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Abstract. This reflection paper presents an argument with justification for including diverse representations of embodied self in the design of virtual training systems and smart learning environments. A great number of VR training programs exist and they are becoming more widespread with the advent on consumer VR. Evidence supports that embodiment of self through avatars impact engagement and transfer of behavior outside of virtual space. It is important that these factors are taken into consideration during the initial stages of development, as it is much easier to design a system with a diversity component and opportunities for customization than it is to redesign an existing system to represent diverse users. This discourse is informed by perspectives from literature on cognitive and behavioral effects of embodiment in virtual spaces. This is also informed by insights from the multi-billion dollar game industry that has struggled to include more diverse representations in recent years.

Keywords: Virtual Reality · Training · Diversity · Inclusion · Instructional Design · Immersion · Mixed Reality

1 Introduction

While there is a substantial amount of educational technology available for both traditional education and workplace training, inclusion of culturally diverse avatars to facilitate accurate embodiment is frequently a low or nonexistent priority. When making decisions of costs in terms of development time or purchasing diverse character models, the choice is often to not include diverse representation. While the adoption of consumer virtual reality (VR) is in its nascent state of adoption, it is projected that VR will be a 21.5 billion U.S. dollar market by 2020 [1]. Some evidence that supports this projection of mass adoption is seen by the number of companies that are turning to VR headsets for training. For example, Walmart is using VR to train 150,000 employees for black Friday, school districts are using VR to train teachers, and an increasing number of US football teams are using VR to provide additional training to football players [2,3].

1.1 What Is Virtual Reality?

While there is a continuum of immersive technologies that are frequently referred to as virtual reality (VR), for the purposes of this discourse, the authors have included a spectrum of activities that refer to themselves as virtual learning [3]. These range from experiences that occur in a three dimensional virtual space and are interacted with through a computer

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screen, and also include 360 degree video experiences created for education or training. Developers and practitioners also include the highly immersive experiences of a virtual space rendered in a head mounted display that create the highest levels of engagement through high levels of presence (the sense of being "there").

1.2 What is Embodiment?

Embodiment refers to the sense that one has a body that is interacting in a virtual space, inversely, if someone has a "disembodied" self in a virtual space, which refers to the body having no representation in the space [4]. This is essentially the difference between seeing one's virtual body, or not having a virtual body. A quote from Yee and Bailenson explain the significance of embodiment best, "The avatar is not simply a uniform that is worn, the avatar is our entire self-representation" (p. 274). [4]. Many studies have identified the real connection that individuals experience with both embodied and disembodied selves in virtual environments [5, 6]. This is consistent with the assertions that the advances in technology will continue to increase levels of fidelity and presence, in which their embodiment in environments will be a significant consideration [7, 8].

Newer studies that use the emerging technology, such as the Long Arm Study, have identified a connection that individuals experience with both embodied and disembodied selves in virtual environments [6]. People have demonstrated physiological changes in connection to actions that are taken on their physical representation in space. "The increased cognitive connection achieved through facial and body similarities between users and their avatars builds positive attitudes (e.g., affection, connection, and passion), which in turn increase the usefulness of an avatar" (p. 726) [9].

2 The Importance of Embodiment.

The argument of this paper is that representation of avatars used for embodiment matters. With very little research on the area of race and gender embodiment, the literature suggests that these constructs of diversity will also have an impact. It matters because it effects behavior. Embodiment also impacts user satisfaction and learning outcomes.

2.1 Embodiment Effects Behavior

Proteus Effect. Early VR studies revealed the Proteus Effect in which individuals conform their behavior to match the avatar by which they are [4]. In this research, it was revealed that users' confidence increased when they felt they had a more attractive avatar. Further, user confidence increased if they had a taller avatar. Not only did user's confidence increase, their behavior in a negotiation task demonstrated the increased confidence. This finding is frequently cited to demonstrate the importance of embodiment.

Similarity to Self. When asking the question, "what happens when your avatar looks like you," researchers [9] found evidence that similarity to self in embodiment matters. By generating an avatar that looked like the user through a body scan, they were able to measure affinity to the avatar that looked like the user. Not only did users report more affinity to their avatar, they also reported that they were more likely to use the avatar people who did not feel their avatar looked like them. This suggests representation impacts both self and mentor embodiment.

2.2 Embodiment Effects Satisfaction

Game Industry Research. While the area of research is new, we can also be informed from perspectives about personalization from the game industry. Research has demonstrated, not only an increase in gamer satisfaction when given more customization options, but also this increase in satisfaction correlated to increased retention rates [10]. This mirrors reports that many game critics, organizations such as "I Need Diverse Games," scholars, and customers have proclaimed for years [11].

Open Responses. In an ad hoc Twitter poll asking gamers if they thought it was important that there are diverse characters in games, 57% of the 386 respondents expressed that diverse representations matter in games. Further, of the 43% of people who said they did not care, there were many comments to the effect of thinking it to be a nice, but unnecessary feature. This question would need to be tested with a representative sample.

2.3 Embodiment Effects Learning

With the existence of so many computer based trainings that fail to engage users, it is important to consider evidence that demonstrated that learning in environments empower users to connect with a virtual space through embodied self is more effective [12]. Further, it is common for users of training systems to request diverse representations [3].

3 Beyond User Embodiment: Embodying Trainers

Existing knowledge about effective training in the physical world can inform the choices made in the design and development of virtual training experience. Mentoring and experiential learning are considered some of the most effective workplace training and development techniques [13]. VR training that uses mentors could also consider the inclusivity of the trainers and mentors. The VR experience allows for the inclusion of multiple virtual mentors that could create affinity and connection with learners. Engagement is a well-established factor in learning outcomes and including this consideration of diverse representations could increase learning and transfer of learning [14,15]. Further, research has demonstrated that trainee success, transfer of knowledge back to the workplace and sense of self efficacy are related to the employee's satisfaction with their trainer [16]. While representation is only one aspect of the trainer identity that could effect the trainee's sense of satisfaction with the trainer, the advances of technology afford for the development of multiple virtual training or mentoring avatars within a single experience. This would enable learners the autonomy to choose the virtual trainer profile they prefer.

4 Conclusion

More research needs to be done on the impact of diverse representations and customization of avatars in Virtual Learning environments to investigate the hypothesis that inclusivity in these representations would increase intent to use, satisfaction, and learning outcomes. The literature suggests that this would improve outcomes, but more research can be done to explore hypothesized benefits. A simple opinion poll to investigate the demand for inclusivity would be useful, but a full study to explore empirical evidence on the impacts would inform both industry and academia as to the potential benefits versus cost. This research could drive designers and developers to consider the benefits to affinity of mentors and trainers.

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Design of Online Teacher Training Mode: a Cognitive Apprenticeship approach

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Abstract. In order to solve the problems in online teacher training and innovate teacher training mode, we designed a learning-centered online training mode. In this paper, we used Cognitive Apprenticeship (CA) as the design framework, addressing the research question: How can CA be used to inform the instructional design of an online teacher training? We applied the four components of CA to our instructional design and fully described how they be applied to this online training mode. This is also a blended training mode, which blended teachers' online learning and offline practice. In practical application, we also developed an online learning system, called Teacher Workshops System (TWS), to support the training activities. The application shows that this training mode has indeed changed the way teachers learn and promoted their teaching practice, but the effectiveness of this mode will be affected by many factors.

Keywords: teacher training, online learning activities, cognitive apprenticeship, instructional design

1 Introduction

In 2010, the National Training Plan was began to implement in China and this plan is an important measure to improve the quality of K12 teachers, especially rural teachers. In this plan, online training is one of the main ways. Online training solves the time conflict between work and learning, expands the scale of training, and saves the cost of training, so more rural teachers get training opportunities. But most online training just provide the lectures of experts, which mainly focuses on knowledge transfer. Many teachers complain that the content of training are not what they need or they cannot apply what they have learned into their teaching practice without follow-up support, so teachers have no strong learning motivation and the training effect is not good. So people began to reflect on the training mode and began to explore new online training mode (Ma, 2011).

In 2013, aiming at the problems in distance training, the National Training Plan explicitly proposes to innovate online training mode to blend online training with offline practice (Ministry of education, 2013). Different online training modes are

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established, some based on virtual community, tools of web 2.0 and so on, but there is no effective design of learning activities. (Yang, 2012).

From 2014, we began to undertake the online teacher training program in our district and think about the design of teachers' online learning activities to solve the above problems.

2 The cognitive apprenticeship

Cognitive apprenticeship (CA) was proposed by the cognitive scientists Collins and his colleagues in 1989. CA concentrates on developing the mental models and cognitive and meta-cognitive skills that learners need in order to perform tasks in more expert-like ways, by focusing on 'learning-through-guided-experience' (Collins et al. 1989). CA was aimed primarily at teaching processes that experts use to handle complex tasks and emphasizes that knowledge must be used in solving real-world problems. The cognitive apprenticeship perspectives on the sociocultural and situated of knowledge and leaning are consistent with the views of teacher learning and teachers' practical knowledge.

CA focus on four dimensions that constitute any learning environment: content, method, sequencing and sociology, each with several features and characteristics (Collins, Hawkins, &Carver, 1991).It is a well-recognized instructional approach that encourage a learning-centered approach. This approach has been put into practice in a variety of instructional fields, include online learning such as online vocational education (yang, 2008), online course design (Benilde.G et al., 2018), pre-service teacher education (Alger & Kopcha, 2010).

In this paper, we used CA as the design framework, addressing the research question: How can the Cognitive Apprenticeship be used to inform the instructional design of an online teacher training? The four components of CA were applied to our instructional design and we will fully describe how they be applied to the learning environment for teachers.

3 Methods and procedures

We first considered the composition of the community of practice which includes an expert teacher and a group of trainees (novice teachers), then designed a process model of teachers online learning activities which included a series of instructional events that applied the principles of CA (See Fig.1).

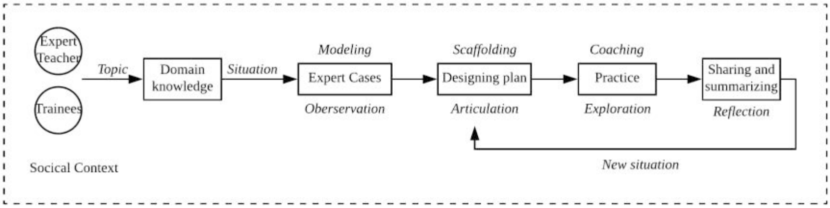

Fig. 1. A process model of teacher's online learning activities

The following sections we will discuss and fully describe how the principles of CA were applied to this model. In practical application, we developed an online learning system, called Teacher Workshops System (TWS, http://workshop.jxteacher.com/), to support the training.

3.1 Sociological context

Community of practice: A group of expert teachers are selected and each of them can open a learning space, called workshop, in TWS. Now, there are more than more than 100 workshops with different topics. Trainees can join anyone according to their needs. Here, teachers have a common learning goal and participate in the training activities organized by expert teacher.

Situated learning: The topic of every workshop is a real problem from teaching practice. Teachers learn from the problem and then practice in their own teaching.

Intrinsic motivation: the learning topic is the real problem in teaching practice and can meet the needs of trainees. With the guidance of expert and the help of peers, teachers' teaching ability can be improved, so learning activities was thus engendered and teachers are intrinsically motivated to become expert teachers.

Cooperation: In community of practice, trainees can share and communicate, cooperation is obvious. Moreover, every 3-4 teachers were formed into a group and observe each other.

3.2 Sequencing of learning activities

CA provides the keys to ordering learning activities, including increasing complexity, increasing diversity and global to local skills. The order of activities should be designed to guide learners in a manner that maximizes learning. Based above, we designed the sequence of learning activities to guide teachers. TWS supports expert teacher to set up a timeline and this sequencing of activities was conveyed to trainees through the timeline. These learning activities usually will last three months, so teachers have the opportunity to practice what they have learned.

Increasing complexity: learning begin with basic concepts, then followed by case study, imitation, practice, and problem solving in multiple contexts and increasingly more complex knowledge which is necessary for expert performance are required.

Increasing diversity: Trainees were exposed to a variety of situations by interacting with case studies and sharing their own cases in practice, so that they could appropriately generalize their knowledge and skills.

Global to local skills: This principle focus on conceptualizing the whole tasks before executing the parts. Before learning, a syllabus will be presented to the learners, including goals, learning contents, schedule of activities, requirements, etc. Before learning a certain teaching method, a clearing conceptual model of the overall activity would be show to trainees.

3.3 Content

When the leaning activities have been identified and sequenced, we can see that different learning stage will focus on learning different knowledge.

Domain knowledge： Learning begin with domain knowledge: the concepts, facts, descriptions of procedures, and models in a certain teaching method, which is necessary for expert performance. Trainees can learn it by some materials, such as micro video. But domain knowledge isn’t sufficient, teachers need strategic knowledge to make use of domain knowledge to solve real -world problem.

Strategic knowledge: Strategic knowledge can be learned through observation of experts demonstrating their decision-making process and by discussing what they did and why. In case study, the expert teacher will explain why this teaching should be done. In the process of simulation and practice, trainees’ interpretation of their own teaching ideas and the guidance of expert teacher will help them to acquire strategic knowledge.

3.4 Method

There are six teaching methods of CA, which give learner the opportunity to observe, engage in and invent or discover expert strategies in context (Collins, 2006).

Modeling: TWS support expert teacher to upload teaching cases for modeling and expert teacher would show an explanation of teaching decisions and the reasons for making those decisions during the modeling demonstration. Trainees observe the thinking and behavior of expert teacher how to solving problems in teaching cases.

Coaching: In TWS, when trainees design and practice their own teaching plans, expert teacher will observe them and provide support. Meanwhile trainees need encouragement and feedback.

Scaffolding: When trainees initially design their own teaching plan, they can't do well, so expert teacher will provide a teaching plan template and some tips to support them. These support won't be needed gradually as trainees become more and more independent.

Articulation: At online discussion board expert teacher led questions and encouraged trainees to express their understanding of the knowledge and thinking about the problem and associated challenges. Trainees were asked to make two formal presentations. The first was a presentation of their proposals that included their initial understandings about the problem and a teaching plan. The second was a presentation of the result of problem solving and the reflection after teaching practice. The presentations are required to be submitted by micro video.

Reflection: The purpose of reflection is to provide learners with opportunities to compare their own performance with that of experts or other colleagues (Collins et al., 1991). After trainees applied their teaching plan to authentic situation, they were asked to reflect on their own knowledge and performance and compare them with their peers and expert teacher.

Exploration: Learners should be given opportunities to identify their own problems and provide their own solutions (Collins et al., 1991). This blended training mode emphasizes the active exploration of trainees because they were asked to solve real problems in the teaching situations and were guide to pay attention to the sub problems in practice and explore further.

4 Conclusion and discussion

In 2014, when we began to undertake the online teacher training program in our region, we thought about establishing a learning-centered teacher training mode to stimulate teachers' initiative and promote teachers' teaching behavior change. The instructional design of this online training mode was conducted by Collins's (2006) cognitive apprenticeship, which permitted us to design online activities that directly addressed both teachers learning needs as well as their authentic professional needs. This paper as a demonstration of how online learning activities can be designed and implemented to support teachers' learning and practice.

Based on this training mode, we have implemented three rounds (once per year) of online teacher training, and in this process, we have constantly improved through internal evaluation. Through interviews with trainees, it is shown that they can choose the learning content they need and it is a different way from the previous training mode, and the training promoted their teaching practice. However, the effectiveness of this mode will be affected by many factors, such as the design of the topic, the number of participants in each workshop, the ability of expert teachers to organize learning activities and the ability to support and guide trainees, online learning ability of trainees, and so on. So there are still many problems worth studying.

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Diagnosis with Linked Open Data for Question Decomposition in Web-based Investigative Learning

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Abstract. In Web-based investigative learning, learners are expected to construct wider and deeper knowledge by navigating a great number and variety of Web resources/pages. On the other hand, they tend to search a limited number of them, which often results in limited knowledge construction. In order to make the investigation with an initial question elaborate, learners need to decompose the question into related ones. They also need to create a scenario like a table of contents implying the questions to be investigated and their sequence. We have built a model of Web-based investigative learning, and developed the system so far. However, it remains an open problem to diagnose learner-created scenario without preventing self-directed investigation. Toward this problem, this paper proposes a diagnosis method with Linked Open Data (LOD), and reports a case study whose purpose was to evaluate the diagnosis method.

Keywords: Web-based investigative learning, Linked Open Data, Self-directed learning, Diagnosis

1 Introduction

It is recently becoming more important to acquire the skill to utilize information, which is one of 21st-century skills [1]. Learning on the Web is particularly suitable for acquiring it [2]. The Web allows learners to investigate any question to learn from a great number and variety of Web resources in a self-directed way [3]. In Web-based investigative learning process, learners are expected to construct wider and deeper knowledge from their point of view [4], in which they select the Web resources/pages suitable for learning to navigate across them, and to integrate the contents learned at the navigated resources/pages by themselves.

On the other hand, learners tend to search a limited number of Web resources/pages for investigating a question, which often results in an insufficient investigation and limited knowledge construction. In order to make Web-based investigation with an initial question elaborate, it is necessary for learners to deepen and widen the question, which requires them to identify related questions to be further investigated during their navigation and knowledge construction [3]. This corresponds to decomposing the initial question into related ones as sub-questions.

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In addition, learners are not provided with a scenario like a table of contents implying the questions to be investigated and their sequence. The learners accordingly need to create a scenario by themselves, which involves decomposing a question into the sub-questions for an elaborate investigation. Such a learner-created scenario would be helpful for learners to self-regulate their navigation and knowledge construction process [5]. But it is difficult for them to create their own scenario concurrently with navigation and knowledge construction.

In our previous work, we have proposed a model of Web-based investigative learning, and developed the system named interactive Learning Scenario Builder (iLSB for short) [6]. We have also confirmed iLSB could promote elaborate investigation and scenario creation [7]. On the other hand, it remains unclear whether scenario created by learners is appropriate.

This paper addresses a challenging issue how to diagnose the appropriateness of learner-created scenario in Web-based investigative learning. A general approach to this issue is to provide a correct scenario to compare with learner-created scenario. However, it is quite difficult to uniquely define it since Web-based investigative learning could bring about various question decomposition for an initial question. In addition, correct scenario provided would prevent learners from self-directed investigation.

Towards this problem, this paper proposes a method for diagnosing learner-created scenario with Linked Open Data (LOD), in which the appropriateness of relationships between a question and the sub-questions decomposed in the scenario is examined. We also report a case study whose purpose was to evaluate the validity of the diagnosis method. The results suggest that it could properly diagnose question decomposition.

2 Web-based Investigative Learning

First, we describe the model of Web-based investigative learning [6], and iLSB [7]. We then discuss the necessity for diagnosing learner-created scenario.

2.1 Model of Web-based Investigative Learning

This model includes three cyclic phases: (a) search for Web resources, (b) navigational learning, and (c) question decomposition. In phase (a), learners are expected to search and gather Web resources suitable for learning about an initial question using a search engine with a keyword representing it (called q-keyword), and to explore across their resources. In phase (b), they are expected to navigate the Web pages gathered in phase (a), and to extract keywords representing the contents learned in the pages to construct their knowledge. In phase (c), the learners are expected to find out some related sub-questions to be further investigated about the initial question, which are selected from the keywords extracted in phase (b). This corresponds to decomposing the initial question into sub-questions. Each sub-question is also investigated cyclically in the next phases (a) and (b).

The question decomposition results in a tree called question tree, which includes part-of relationships between the question and the sub-questions. The root of the tree represents the initial question. This tree also represents a learning scenario. Creating the tree corresponds to defining the initial question, which specifies what to investigate and how.

2.2 iLSB

We have developed iLSB as an add-on for Firefox. Fig. 1 shows the user interface of iLSB. iLSB provides learners with functions for scaffolding their investigative learning process: search engine, keyword repository, and question tree viewer.

Let us here describe how iLSB scaffolds question tree building with an example of investigation about “Global warming”. Learners are first expected to input “Global warming” as an initial q-keyword to the search engine, which is located in the root of question tree. iLSB allows them to search for “Global warming” and select/navigate the Web resources/pages. The learners second store keywords in the keyword repository, in which keywords represent the contents learned in the navigated pages. They then make inclusive relationships among stored keywords, and find out sub q-keywords to be further investigated. They also add the sub q-keywords to question tree viewer, and make part-of relationship from the root. The learners are next expected to investigate these sub q-keywords in the same way. As shown in Fig 1, the initial q-keyword “Global warming” is decomposed into three sub q-keywords such as “Greenhouse gas”, which is furthermore decomposed into the sub q-keyword “Carbon dioxide”.

2.3 Issue

In Web-based investigative learning, learners often investigate unrelated sub-questions for an initial question even if they use iLSB. This suggests the necessity of diagnosing learner-created scenario. A general approach to this issue is to provide a correct scenario, and to compare it with learner-created scenario. However, it is difficult to uniquely define the correct scenario since each learner can create his/her own scenario even for the same initial question. In addition, providing the correct scenario would prevent learners from self-directed investigation.

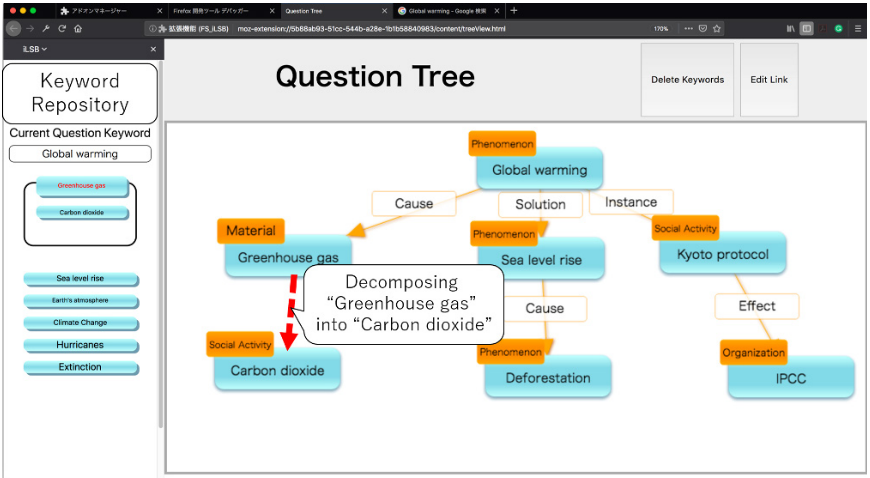

Fig 1. User Interface of interactive Learning Scenario Builder (iLSB)

Toward this issue, we aim to diagnose the appropriateness of question decomposition in learner-created scenario with LOD. The appropriateness of question decomposition is evaluated by means of DBpedia Japanese as LOD, in which iLSB calculates the relevance and similarity between the initial q-keyword and q-keywords decomposed, and the ones between the q-keywords and its parent q-keywords. The calculated results could be present to learners as feedback, which allows them to reflect on their question decomposition and scenario creation.

3 Method of diagnosis decomposed questions

Let us here describe how to diagnose learners' question decomposition with LOD.

3.1 Linked Open Data (LOD)

Linked Open Data is a set of structured data interlinking with related ones on the Web such as DBpedia Japanese [8] and YAGO [9]. In this work, we use DBpedia Japanese as LOD whose data are prepared for Japanese Wikipedia. Japanese Wikipedia is one of reliable [10] and structured resources for investigative learning. The data in DBpedia Japanese are expressed RDF (Resource Description Framework), which are encoded in a triple form of subject, predicate and object. A collection of triples can be represented as graph called RDF graph. In order to extract RDF data and operate RDF graph, it is necessary to send SPARQL query, which is a query language to operate RDF data stored in LOD. By means of SPARQL query, it is possible to measure distance between q-keywords in DBpedia Japanese, and to extract words related to q-keywords.

By means of distance between q-keywords, it is possible to calculate the relevance between q-keywords. In addition, it is possible to calculate the similarity between q-keywords by comparing related words of each q-keyword. The appropriateness of question decomposition is evaluated with the relevance and similarity between the initial q-keyword and q-keywords in question tree, and the ones between the questions and its parent question.

3.2 Framework of Diagnosis

Fig. 2 shows the framework of diagnosing the appropriateness of question decomposition.

The diagnosis is implemented as a function of iLSB. Let us explain the framework with an example of decomposing “Greenhouse gas” into “Carbon dioxide” when learners build a learning scenario about the initial question “Global warming” shown in Fig. 1. In order to evaluate the appropriateness of decomposing into the sub question “Carbon dioxide”, in this case, iLSB calculates the relevance and similarity of part-of relationship between “Greenhouse gas” and “Carbon dioxide”, and the ones between “Global warming” and “Carbon dioxide” by sending the SPARQL queries. The queries measure the distance and number of paths between these q-keywords, and obtain related words of each q-keyword. iLSB then diagnoses the appropriateness of question decomposition as one of three levels, such as appropriate, weak appropriate and unknown. iLSB gives the learners feedback about the appropriateness diagnosed.

4 Diagnosis of question decomposition

The appropriateness of question decomposition is evaluated with two criteria that are the relevance and similarity between q-keywords included in the question tree created by learners. Let us here describe how to calculate these criteria with DBpedia Japanese. We also describe a diagnosis procedure, which evaluates the appropriateness of question decomposition.

4.1 Relevance between q-keywords

Relevance is basically calculated by means of the distance and the number of paths in DBpedia Japanese between two q-keywords in question tree, which are obtained

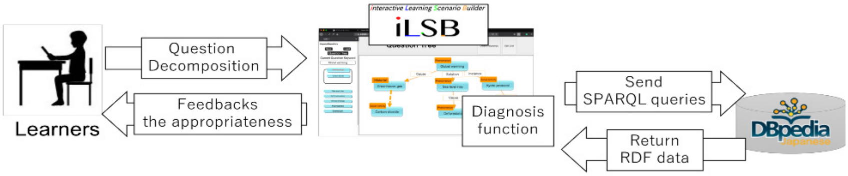

Fig 2. The framework of diagnosis

by SPARQL query. The query includes these keywords as its subject and object with any predicate. For example, the distance and number of paths between q-keywords "Greenhouse gas" and "Carbon dioxide" are measured with the following query1:

```
SELECT DISTINCT *
WHERE{
  {
    FILTER(contains(str(?subject_name),"Greenhouse gas"))
    FILTER(contains(str(?object_name),"Carbon dioxide"))
    ?subject rdfs:label ?subject_name.
    ?subject ?predicate ?object.
    ?object rdfs:label ? object_name.
  }UNION{
    FILTER(contains(str(?subject_name),"Greenhouse gas"))
    FILTER(contains(str(?object_name),"Carbon dioxide"))
    ?subject rdfs:label ?subject_name.
    ?subject ?predict1 ?middle.
    ?middle ?predict2 ?object.
    ?middle rdfs:label ?middle_name.
    ?object rdfs:label ?object_name.
  }
}
```

Query1: An example of SPARQL query

According to the distance and number of paths measured, iLSB decides the relevance as one of three levels: relevant, weak relevant, and unknown. We have conducted several preliminary examinations with several domains for deciding relevance level by means of the distance and the number of paths between keywords in DBpedia. The results suggest that keywords are relevant if the distance is 1, and they are weak relevant if the distance is 2 and the number of paths is more than 30. The relevance of keywords is suggested as unknown if the distance is more than 3 or the number of paths is less than 30. Following the lessons learned from the preliminary examinations, iLSB decides the relevance level of two q-keywords in question tree.

When the learners decompose "Greenhouse gas" into "Carbon dioxide" shown in Fig 1, for example, iLSB first sends the query1 to DBpedia Japanese. iLSB then obtains the distance and number of paths between these keywords. Since the distance between them is 1, in this case, the relevance between them is decided as relevant.

4.2 Similarity between Q-keywords

Similarity is defined with the intersection of two sets, each of which consists of related words for each of two q-keywords in question tree. The related words are obtained by morphological analysis of the results received with SPARQL query to DBpedia Japanese. It is evaluated by means of overlap coefficient as follows:

$$\text{overlap}(X, Y) = \frac{|X \cap Y|}{\min(|X|, |Y|)} \quad (1)$$

where X is a set of related words to one q-keyword, and Y is a set of related words to the other q-keyword. For example, the related words of "Greenhouse gas" are obtained with the following query2 and morphological analysis:

```
SELECT DISTINCT ?object
WHERE{
    FILTER(contains(str(?subject_name),"Greenhouse gas"))
    ?subject rdfs:label ?object_name.
    ?subject ?predicate ?object.
    FILTER(strStarts(str(?object),
     "http://ja.dbpedia.org/resource/"))
}
```

Query2: A SPARQL query for obtaining related words

According to the overlap coefficient calculated, iLSB decides the similarity as one of three levels: similar, weak similar, and unknown. We have also conducted several preliminary examinations with several domains for deciding similarity level by means of the value of overlap coefficient between keywords in DBpedia Japanese. The results suggest that keywords are similar if the value is more than 0.3, and they are weak similar if it is from 0.1. to 0.3. The similarity of keywords is also suggested as unknown if the value is less than 0.1. Following the lessons learned from these examinations, iLSB decides the similarity level of two q-keywords in question tree.

As for "Greenhouse gas" and "Carbon dioxide" in Fig1, for example, iLSB first sends the query2 and the one replacing the subject of the query2 with "Carbon dioxide". iLSB then obtain words related to "Greenhouse gas" and "Carbon dioxide" from DBpedia Japanese and creates two sets including the related words with the morphological analysis. iLSB then calculates the overlap coefficient between the sets. Since the overlap coefficient between "Greenhouse gas" and "Carbon dioxide" is 0.5, in this case, the similarity is decided as similar.

4.3 Diagnosis Procedure

In diagnosing the appropriateness of question decomposition, we design a diagnosis procedure as shown in Fig.3. In this procedure, iLSB first calculates the relevance and similarity between question *i* (represented as q-keyword *i*) and the initial question (represented as the root q-keyword of question tree), and then calculates the ones between the question *i* and its parent question (represented as parent q-keyword). Depending on the calculated levels of relevance and similarity, iLSB decides the appropriateness of decomposing into the question *i* as one of three levels: appropriate, weak appropriate, and unknown. iLSB evaluates the appropriateness of each sub-question decomposed in the same way to diagnose question decomposition done by learners.

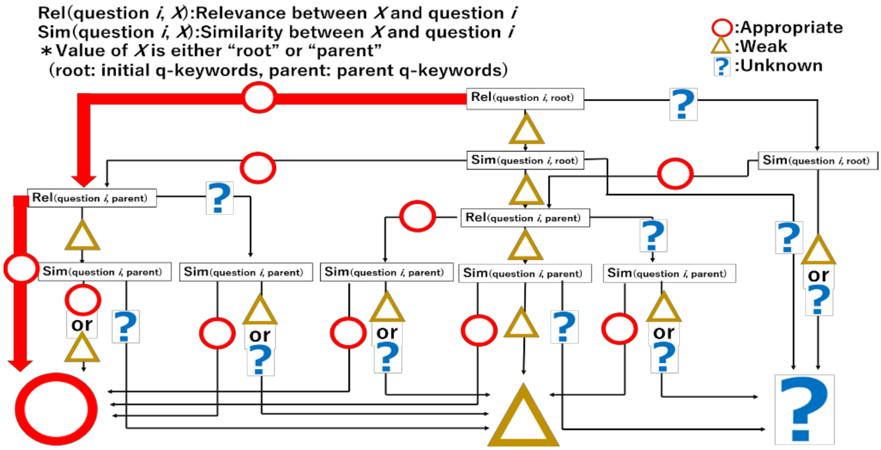

Fig 3. Diagnosis procedure

When learners decompose “Greenhouse gas” into “Carbon dioxide” in Fig 1, for example, iLSB calculates the relevance and similarity between “Global warming” and “Carbon dioxide”, and the ones between “Greenhouse gas” and “Carbon dioxide”. As shown in Fig.3, all these relevancies and similarities are evaluated as relevant and similar in this case. iLSB accordingly diagnoses the appropriateness of decomposing into “Carbon dioxide” as appropriate.

5 Case Study

5.1 Purposes and Procedure

In order to evaluate the validity of the designed procedure shown in Fig.3, we have had a case study where the appropriateness of question decomposition diagnosed with the procedure was compared to the one diagnosed manually. First, 9 graduate and undergraduate students in science and technology used iLSB to investigate two initial questions: "Tax" and "Judicial system". They then created their own learning scenarios for each question.

Second, these learner-created scenarios were diagnosed with the proposed procedure, in which each q-keyword decomposed in the question trees was examined. Third, three evaluators selected from the authors of this paper manually and carefully checked the appropriateness of question decomposition by referring to reliable Web resources, in which each q-keyword decomposed in the question trees was also examined. It was decided by majority of the three evaluators. In case each evaluator diagnosed it as different level, it was decided as weak appropriate.

Finally, we compared the appropriateness of the question decomposition diagnosed with the procedure and the one diagnosed manually, and evaluated the validity of the procedure. We used accuracy, recall, precision and F-measure as to the number of appropriateness level diagnosed for each sub q-keyword included in the 18 learner-created scenarios in total.

In evaluating the validity, in addition, we considered that the question decomposition diagnosed as weak appropriate was meaningful for learners to investigate in a self-directed way. In this work, we accordingly regard weak appropriate decomposition as appropriate one to evaluate the validity of the procedure. In other words, we compared the number of appropriate and weak appropriate decomposition with the one of unknown decomposition in learner-created scenarios.

5.2 Results and Discussions

Table 1 shows the numbers of appropriateness levels diagnosed with the designed procedure and manual diagnosis. The accuracy of question decomposition diagnosis with the diagnosis procedure and on manual was 77.8% (=224/288), which seems high. Table 2 also shows the recall, precision and F-measure as to the ratios of the diagnosis with the designed procedure to the manual diagnosis.

As shown in Table 2, the precision of appropriate question decomposition diagnosed with the procedure was almost 90%, and the F-measure was also quite high. The recall was also comparatively high. These results suggest that the question decomposition diagnosed as appropriate is evaluated validly.

As for question decomposition diagnosed as unknown, on the other hand, the precision was about 55%, which was lower than others, although the recall was about 75%. These results suggest that the designed procedure could properly diagnose unknown decomposition but misdiagnoses appropriate decomposition as unknown. The main reason is that the question decomposition includes keywords not to be obtained from DBpedia Japanese. This is the limit of LOD usage. We need to use other LODs, which is an important future work.

From the above discussion, the diagnosis results are not necessarily correct, but these seem instructive for learners to reflect on their question decomposition.

Table 1. Numbers of appropriateness levels diagnosed

<table>
<tr><td colspan="3" rowspan="3"></td><td colspan="3">Diagnosis procedure</td></tr>
<tr><td colspan="2">Appropriate</td><td rowspan="2">Unknown</td></tr>
<tr><td>Appropriate</td><td>Weak appropriate</td></tr>
<tr><td rowspan="3">Manual diagnosis</td><td rowspan="2">Appropriate</td><td>Appropriate</td><td>104(Q1:51,Q2:53)</td><td>30(Q1:6,Q2:24)</td><td>18(Q1:4,Q2:14)</td></tr>
<tr><td>Weak appropriate</td><td>23(Q1:18,Q2:3)</td><td>11(Q1:5,Q2:6)</td><td>27(Q1:6,Q2:21)</td></tr>
<tr><td colspan="2">Unknown</td><td>8(Q1:3,Q2:5)</td><td>104(Q1:51,Q2:53)</td><td>56(Q1:36,Q2:20)</td></tr>
</table>

Q1: Judicial system, Q2: Tax

Table 2. Recall, precision and F-measure of diagnosis procedure toward manual diagnosis

	Precision	Recall	F-measure
Appropriate & Weak appropriate	89.8%	78.9%	0.84
Unknown	55.4%	74.7%	0.64

6 Conclusion

This paper has addressed the issue how to diagnose the appropriateness of learner-created scenario without preventing learners from self-directed investigation with Web resources. We have also proposed a method for diagnosing learner-created scenario with LOD. In addition, we have reported the case study to evaluate the validity of the designed diagnosis procedure. These results suggest that the designed procedure could properly diagnose unknown decomposition but misdiagnoses appropriate decomposition as unknown. As a future work, we will ascertain whether the diagnosis method can promote reflection on question decomposition and self-directed investigation.

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Emarking: A collaborative platform to support feedback in higher education assessment

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Abstract. This article reports on six years of experience on the continuous redesign and implementation of a collaborative marking platform to support summative and formative feedback in higher education. The design follows principles of feedback quality, collaboration between teachers and students, and institutional requirements for administrative features. The platform includes modules for printing management, scanning support, on-screen-marking, markers training and peer reviews by students. The goal of the platform is to reduce the cost of providing quality feedback by the reuse of annotations and comments, the use of rubrics, and the collaboration between markers, which can monitor inter-rater agreement through real marking processes.

Keywords: Electronic feedback·collaborative marking·emarking

1 Introduction

The importance of open-ended questions for both summative and formative assessment, have been thoroughly studied in higher education scenarios, and consequently its use has grown in demand in universities around the globe. The value of open-ended questions like essay writing, mathematical demonstrations or concept maps, is that they demand higher cognitive skills form students, like synthesis and the linking of ideas in a coherent whole [1]. However, the quality of such assessments is not guaranteed by the questions themselves, but on the quality of the summative and formative feedback given. Summative feedback, in the form of grades, must be reliable and valid, as they have strong consequences in the life of students [2]. Formative feedback, on the other hand, should be nonevaluative, supportive, timely and specific, as it is expected to support students on their learning [3]. Providing feedback that considers all these dimensions demands an important effort from lecturers, tutors and administrative staff, making low quality feedback a reality in many institutions. Despite recent developments on sophisticated electronic tools to support assessment, to the extent of our knowledge, none of them is concerned with the dimensions of feedback quality, and therefore

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they do not provide support for those tasks [4]. A second problem is that no tools provide ways to collaborate between tutors and lecturers, which leaves the potential that collaborative environments have outside the feedback process. Finally, as assessment is a key institutional process within educational organizations, technologies must meet enterprise requirements like security, reliability, scalability and ease of adoption. The latter is a key aspect for educational technologies, as proctored hand-written exams are still the most common way to assess students in high stake exams, particularly in developing countries. In this article the Emarking platform is presented, which is the result of six years of experience on the continuous redesign and development of a software to support the collaborative assessment marking process of open-ended questions [5].

2 Theoretical framework

2.1 Quality of feedback dimensions

Feedback can be summative (grades) or formative (annotations and comments). Summative feedback quality dimensions are: Validity and reliability. Validity is the extent to which an assessment measure what it is supposed to measure. Reliability is the consistency by which an assessment is applied to different subjects and marked by different judges. Validity is usually measured against expert consensus reached following a specific process like Delphi. Reliability is measured calculating inter-rater and intra-rater agreements [2]. Formative feedback quality dimensions are: Nonevaluative, supportive, timely and specific. Nonevaluative refers that it should not produce a grade, as its focus is on learning. Supportive is the extent by which the feedback helps students on improving, not only on identifying mistakes, but also providing ways to tackle those mistakes. Timely refers to the timespan between producing the object to be assessed and obtaining the feedback, which shouldn't be immediate, in order to support reflection, but not too late, so students can link the feedback to their performance [3].

2.2 Enterprise systems architecture

Enterprise systems pose demands to software design and development that are not necessarily related to its core function. In the case of a marking platform, the most relevant features are the students' work and the teachers and tutors' feedback. However, academic institutions require their assessment processes to be reliable and secure, demanding platforms than can support thousands simultaneous students being assessed, with no loss of data. For Emarking, its design was originally ideated as a plugin for an Open Source Learning Management System Moodle platform, which is a state-of-the-art system that currently supports teaching and learning processes worldwide.

2.3 Collaboration

Researchers have shown that collaboration usually outperforms cooperation and individual performance in many tasks, arguing that collaboration is a richer process than traditional communication, adding that collaborative groups are innovative, productive and have a greater level of satisfaction [6]. We argue that the marking process can be thought as a collaborative task, one in which markers collaborate towards a common goal: To produce a high-quality marking work, i.e. an excellent inter-rater agreement and quality formative feedback.

3 Platform description

3.1 Printing module

The printing module allows teachers to upload an exam as a PDF file, which is securely sent to the server, notifying academic coordinators and admin staff. All information is sent encrypted, and none of the roles, not even the teacher herself can download the exam. The platform connects directly to the printer, using an encrypted protocol, and depending on the capabilities of the printing machine, printed exams can be safely stored inside a sealed envelope. If the printing facilities do not allow printing directly from the server, admin staff can download the exam using a two-factor authentication code sent to a mobile phone. Once printed, the sealed envelopes can be delivered to teachers and tutors, whom can rely on the seals to trust their printed exam to be taken.
When creating a new Emarking activity, only two pieces of data are required: A name for the activity and the PDF file of the exam. The exam date allows to implement a minimum period to ensure printing capacity, facilitating the work of administrative staff (enhancing adoption). Admin staff can also be assigned to course categories, which can be used to organize courses according to academic periods and faculties (p.eg: Fall 2019 Economics). An optional parameter at this stage is the personalized header, which corresponds to print a unique copy of the exam per student, with a header including the student name, id and photograph (if available). This parameter must be set if students are expected to answer the exam by hand, and their answers will be uploaded to the system for electronic marking or if they were previously marked by hand.

Finally, reports on the number of pages printed per course, per teacher or department can help management decisions on budgets and printing providers.

3.2 Scanning module

Emarking implements the possibility of uploading students' answers for electronic marking or marking manually and upload the marking results to the platform for distribution of the results and feedback. In order to use this feature, the printing stage must be used with a personalized header, which adds two QR codes to each page (one in the top-right corner and a second in the bottom-left corner), allowing the system to automatically identify its owner, rotate the page or categorize a page as problematic one (orphan page). Finally, in order to ensure scalability, the server does not process exams immediately but in a background process that allows the use of computer processing during idle moments.
Even though the efficacy of the QR codes processing has reached almost 99%, there is an interface to manually identify orphan pages that Emarking could not automatically identify in which the teacher or a tutor can identify the student from the official list and indicate the page number of the unidentified page.

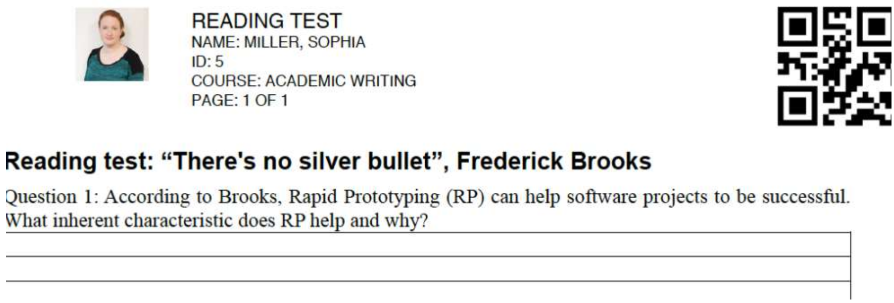

Fig. 1. Personalized header including QR code for scanning.

3.3 On Screen Marking module

Emarking has most of its benefits when marking on-screen. The course main interface shows all the students enrolled in a course and the potential markers for the activity. A "Mark" button next to each student opens the OSM interface, shown in figure 2, which includes the rubric, a set of reusable comments and the student's work. The reusable comments include all comments made by any marker involved in the marking process of an exam along with a set of predefined comments, that teachers can create based on common mistakes that are expected to appear. The interface for creating predefined comments is simple and it allows pasting from

Excel. The rubric is configured by the teacher which can also be imported from Excel for ease of use.

As in higher education assessment processes can be numerous and complex, in which thousands of students are organized in parallel classes, and exams can be long, including several pages and criteria in the rubric. The marking process requires a sophisticated organization and planning. Emarking allows to allocate markers and pages per criterion, allowing to organize marking groups per question or part of a high-stake exam, facilitating the visualization of the marking process. Another relevant aspect for reliability is that the marker should not be able to identify the student she is marking. As the personalized header position is known, an anonymous version of the exam is produced at scanning time, and therefore avoid any judgment problems by making the process fairer.

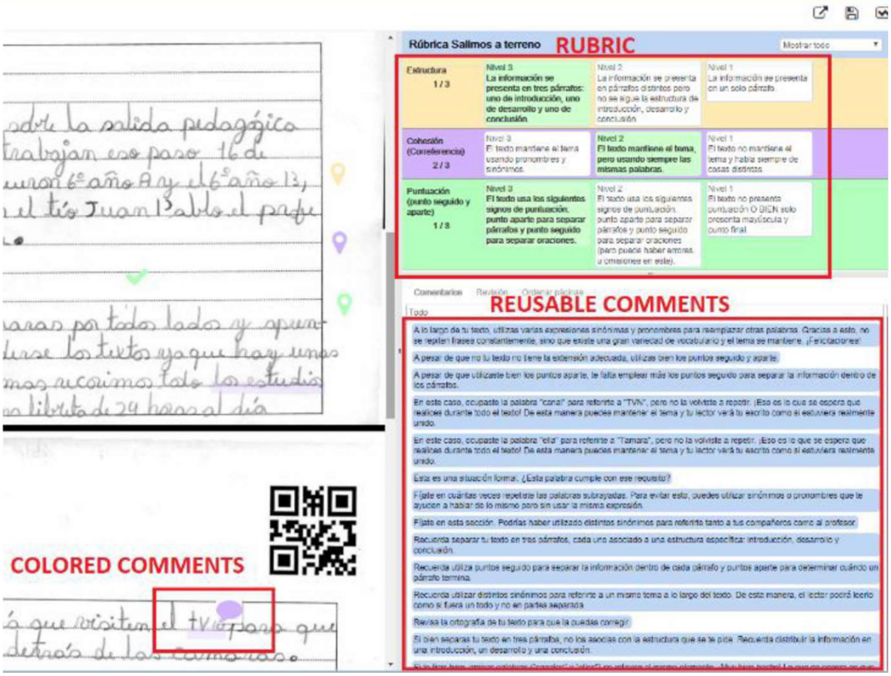

Fig. 2. On Screen Marking interface showing colored annotations and comments, reusable comments and the rubric.

3.4 Markers training

In order to improve the validity and reliability of marking processes, assessment instruments (exam questions and rubrics) must be tested and markers must be trained. The platform implements the Real Time Delphi methodology to train markers on the application of a rubric on a set of exams. Such a process requires a group of judges to assess a decision through rounds until they reach consensus. In a marking process, markers are judges, and the decisions are the selected criteria in the rubric. The platform implements a blind marking as first stage, followed by a continuous iteration lead by inter-rater agreement indicators, along with tools for collaboration between markers like chat and a group view of consensus.

3.5 Peer review

Teachers can configure an Emarking activity for students to assess each other in anonymous pairs. In this case, student answers can be scanned and uploaded or imported form another Emarking activity. The system will randomly assign students in pairs and the interface will use anonymous marking for them to assess their peers' work.

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How Technologies Change Classrooms - A Case Study of K-12 Education in Sudan

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Abstract. This study examines technology integration into the classroom in K-12 education in Sudan. The study used official documents (reports and plans) and observation as data sources. The results revealed existence of efforts to integrate technology in terms of e-classrooms, providing some schools with an interactive whiteboard. However, there are challenges hinder the integration of technology such as poor infrastructure, lack of digital skills among teachers'. The study then recommended continuous such effort and involving stakeholders and donors in issues of technology for schools.

Keywords: Technology change classroom; Educational Context; Information and Communication Technology; K-12 Education; Sudan

1 Introduction

Technology is to support learning activities in the classroom, facilitate students learning, access learning resources for both teachers and students and improve the classroom environment [19, 21]. The literature of technology integration into the classroom practice is diverse, however, many studies identified main aspects to deal with this process [14], as instance integrating technology in to school depends on the educational context [20, 16]. This context includes an approach for how to apply technology, school ICT infrastructure, technical support, school principals' involvement, and teachers' digital skills [16, 11]. Furthermore, some studies identified that integration of technology should focus on the good impact of technology in the classroom by considering factors of school practices and teacher practices [4, 13]. School practice refers to school vision for ICT, support for principal, while teachers practice refers to classroom management [17].

However, some challenges still facing some education systems to support schools with technology, these challenges might appear clearly in the less

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developed countries where the educational equipment is less, the government funding for education in a lower amount, the school infrastructure is poor and as a result, the overall educational situation is affected [3]. Sudan as one of these less developed countries [5, 25] trying to improve the educational context by integrating technology into K-12 schools. The federal ministry of general education (FMoGE) has established projects to support schools with technology, however, there are challenges hinder the implementation. Therefore, this study addresses the educational context of K-12 education in Sudan in light of the FMoGE efforts.

2 Literature Review

Diverse studies conducted on the topic of technology integration in the classroom, however, based on the reviewed literature there are two levels of technology integration [9, 15]. The first level is the basic level of technology integration to enhance learning (TEL) through offering the basic requirements of the technological infrastructure (Computer + normal Internet connectivity), digital learning resources, digital curricula, basic digital skills for teachers and students as well as school principals' knowledge about technology integration [18, 12]. The second level is the advanced level of technology(immersive technology in the classroom), this level Includes "diverse array of ICT" [7] such as Augmented reality(AR), virtual reality (VR), artificial intelligence (AI), intelligent tutoring system(ITS), high Internet speed, beside smart or flexible learning space(classroom flexible equipment where classroom could be changed to any situation, adding to learning management system(LMS)), and teachers advance skills in technology and school principals as a leader of technology integration, and availability of digital curricula in a hand of users and student equipment with one-to-one technology devices[7, 23]. Notable, Sudanese studies about technology in education addressed the barriers, teachers' skills, readiness to integrate technology, infrastructure, policy issues and pedagogical practice and e-learning implementation [1, 2, 8, 22]. Nevertheless, the literature of technology in K-12 education in Sudan shared same features in terms of obstacles affecting technology implementation. This because of technology still in the infancy stage [1], addition to the overall situations of the country which is lack behind aspirations and hopes of the Sudanese nation to leverage of the vast resources of the country to support economic and then improve education and social situation

3 Research Questions

Sudan facing challenges economically, consequently, education getting less funding. However, FMoGE has tried to improve the educational context through some projects. Notable, during the years 2017-2018 the researcher has visited around 250 schools in 4 states including the capital state. The observation is the majority of these schools lack of technology infrastructure. Therefore, this study examines the status of technology integration in K-12 schools and figure out to what extent there is access and technology update to enhance the classroom. Thus, the study is driven by the following questions

1. What is the current state of the classroom equipment in K-12 schools' in Sudan?
2. To what extent efforts of FMoGE make the classroom conditions keep update?

To answer these questions, the study collected reports, publications and related document provided by FMoGE and the observation to the school's efforts of technology integration.

4 Research Methodology

The study used documents, reports, plans provided by the FMoGE and observation for more than 250 schools during the school years 2017 and 2018 respectively in four states over 16 states of the country. To analyze these documents, the study used the content analysis which is appropriate for analyzing the text [6]. The documents enabled the study to point out details of the implemented projects as indicators to technology integration and showed the current situation in the schools.

5 Results and Discussion

In this section, the study shows the efforts of FMoGE in terms of projects has implemented to change the classroom situation and improve the learning environment.

5.1 Current situation of the classroom equipment

To integrate technology into schools, FMoGE has established a national e-learning project for school equipment. The project consists of e-classrooms, technology base teacher training, Internet connectivity, and school equipment. Below the study discuss that.

Regarding e-learning projects, FMoGE seeks to build a technology unit in the National Center for Curriculum and Educational Research (NCCER) to make e-curricula (student book- teacher guide – activities book) and providing schools with computer laboratories [24]. The authors believe that this stage is a good introductory step for FMoGE to at least enable schools start to integrate technology, however, this project has more than five years and not achieved in a good manner. The author has visited large sector of schools in different states and has seen that still they use the traditional book, and the e-book is on the website of FMoGE in a pdf format and not a multimedia book. So the need is to make the curricula available, interactive and motivated in multimedia form.

5.2 E-Classroom

Within the project of improving school environment, there are 103 e-classrooms which have been implemented in some states as in states of Sonar ‘‘30’’ classroom, White Nile state ‘‘21’’, North Kordofan ‘‘19’’, East Darfur ‘‘6’’, North Darfur ‘‘15’’, and Northern State ‘‘12’’ [24]. However, there are no details about these classrooms and to what extent it still working or need to be updated or maintained. But also there is a need for more such classrooms to support technology integration in the classroom as a base for smart education and preferable by students as a new type of school environment [10].

5.3 National Access Projects

This project includes 21,860 computer devices distributed to schools and 920 schools connected with the Internet [24]. However, in the year 2017 the researcher conducted an interview with ahead of the teacher training administration in FMoGE and same administration in Khartoum state ministry of education, they identified that interactive whiteboard (IWB) is replaced the computer equipment in schools [24]. Some schools in Khartoum state equipped in a good manner and selected to be a model for digital schools but also the number of these schools is limited. This step also pushes further in this direction but also its need to be more comprehensive, and FMoGE has to involve the community and donors to support schools’ equipment.

5.4 Teacher Training Project

Under this project there are 1,680 teachers were trained on the Sudanese computer driving license (SCDL) included five states as in the White Nile state with 20 trained teachers’, River Nile 1,000, South Kordofan 420, North Kordofan210, and North Darfur 30 teachers trained [24]. Nonetheless, in an interview with teacher training administration in Khartoum state, he identified that the training of teacher on SCDL has shifted to focus on the IWB since 2015 when it existed in Sudan. About the current number of trained teachers, he said this number is not increased so much because of controlling of the ministry of human resources (HR) to the budget of training and as a result, teacher training gets fewer opportunities, and this situation has constrained the training plan implementation of FMoGE. Consequently, the appeal is for the government to deal with this issue and support the teacher training project.

6 Conclusion

According to the discussion above the questions of the study could be answered as follows briefly

1. What is the current state of the classroom equipment in K-12 schools' in Sudan?

The equipment is someway existing, yet not comprehensive. The schools of the capital state are much bigger than the equipped number. The teachers' skills and schools' leaders' knowledge and awareness of technology have to be considered. The study reported the projects that FMoGE tried to implement included e-classroom (103 e-classroom established), teacher training on the computer (1,680 teachers have got SCDL).

2. To what extent efforts of FMoGE make the classroom conditions keep update?

The classroom environment is somehow update by connecting (920) school with the Internet and distributing a number of IWBs. However, the need is for comprehensive equipment and over the countryside to make real technology integration. The study limits to inclusive data, although the researcher has visited a big number of schools, nonetheless there is no up to date statistics for the status of technology. The paper may not highly provide an innovative contribution to the field, however, it reflects the situation of technology in K-12 schools of Sudan and recommendations to FMoGE, stakeholders, and the donors to support Sudan to integrate technology into education.

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Influence of Pre-service and In-service Teachers' Gender and Experience on the Acceptance of AR Technology

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Abstract: Augmented reality has received more and more attention by researchers in the field of education. Because of its rich visual presentations and various user interaction, AR leaning environment has great potential for learning activities. This study used mature UTAUT questionnaires to investigate pre-service teachers and in-service teachers' acceptance of AR technology. The effective participants included 70 pre-service and 50 in-service teachers. Through data analysis of effective participants from the perspectives of gender and experience, we found that 1) Pre-service teachers are more sensitive to social influences than in-service teachers are. For all the participants, 2) Male teachers are more sensitive to social influences than females. 3) Effort expectancy has a negative impact on AR behavioral intention of high-experience teachers. Based on the research results, specific discussions and suggestions are proposed for different teacher groups to improve the technical acceptance of AR in teaching.

Keywords: augmented reality, UTAUT, gender, experience

1 Introduction

In recent years, augmented reality (AR) has been paid more attention by researchers in the field of education and recommended to teachers for teaching[1]. AR has great potential for learning activities because of its rich visual presentations and various user interaction[2], and teachers show their interests and willingness in using AR[3]. However, we found that teachers who really brought AR into the classroom were few. According to researches about teachers' technology acceptance, many factors affect teacher's behavioral intentions to technology, such as gender, age, experience and etc [4]. Having a better understanding of these factors' impacts could let us offer assistance to teachers more pertinently [5].

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Therefore, we conducted a questionnaire survey when we gave lecture to teachers about using AR in teaching. We investigated their basic information and behavioral intentions in adopting AR based on the UTAUT model. In this study, we analyze their acceptance of AR technology from the perspective of gender and experience.

2 Lecture Review

2.1 AR in education

Augmented reality (AR) is a technology that supplements the real world with virtual objects and appears to coexist in the real world. A system based on AR is defined to have the following properties:(1) combines real and virtual objectives in a real environment;(2) runs interactively and synchronously; and (3) aligns real and virtual objects with each other.[6, 7] By 2010, AR was seen in advertising, education, navigation and information[8]. At first, AR has been used to provide more information for learning activities, and it was more widely used in sightseeing and museum guidance [9, 10, 11, 12]. Up to now, more and more AR systems have been used in education and the role of AR systems has become richer and clearer [1, 13].

According to the statistics of M Akcayir, G Akcayir [1], AR has been proved to be able to take advantages on interaction, pedagogical contributions, and learner outcomes. By summarizing the results of previous empirical studies, the impacts of AR on learners is mainly reflected in learning achievements and positive attitudes. Learning achievements are the focus of the studies and almost all of the studies have discussions about it. KH Cheng, CC Tsai [14] founded that imaged-based AR worked on students' spatial ability, practical skills, and conceptual understanding, while location-based AR supported students' inquiry activities. MB Ibanez [15] Suggested that AR could be helpful in learning the basic principles of electricity. Aruiz-Ariza [16] concluded that AR game Pokemon Go increased users' amount of daily exercise and affected their cognitive performance.

Positive attitudes, such as motivation, interest, confidence and so on, has been tested and proved that they could be promoted by AR. THC Chiang [17] showed that primary school students learning with AR-based mobile learning approaches would have higher motivations in attention, confidence and related dimensions. SJ Lu and YC Liu [18] thought that students would be more confident in learning activities by using a program integrating AR.

Based on previous studies, it is clear that every AR system is committed to improving students' learning achievements and positive attitudes. Investigating teachers' acceptance of AR technology contributes to acquire its practice information in teaching activities and recommend it to teachers pertinently.

2.2 The UTAUT Model and Research Hypotheses

In terms of technology acceptance, the commonly used models include TAM, TAM2 and the Unified Theory of Acceptance and Use of Technology (UTAUT) [4]. In recent years, the UTAUT model has been used in an educational context, such as desktop video conferencing [5], and mobile learning [19]. The UTAUT is a more complete a technology acceptance model include six main constructs: performance expectancy, effort expectancy, social influence, facilitating condition, behavioral intention and usage behavior, and four moderating factors: age, gender, experience, and voluntariness. It is based on the synthesis of eight well-established theories and models include the Theory of Reasoned Action, the Motivational Model, the Model of PC utilization, the Theory of Planned Behavior, the Combined TAM and TPB, the Technology Acceptance Model, the Innovation Diffusion Theory and the Social Cognitive Theory. It has proven superior to previous models, which explains 70 % of the variance in user intentions to use technologies [4].

Research on the role of moderating factors can improve the acceptance of certain technologies in certain groups, such as age and experience. For females, the most important drivers of the behavioral intentions to use desktop video conferencing in a distance course were facilitating conditions. For males, general social influence was the most important variable explaining the behavioral intentions to use desktop video conferencing in a distance course. Therefore, males are more sensitive to social influence than females [5]. It is the same with mobile learning [19], but is not in line with other studies [4], [20]. Wong, Teo, and Russo found that a user's experience has a moderating effect on the relationship between effort expectancy and behavioral intention such that effort expectancy affected behavioral intention to use whiteboards more markedly for the limited-experience group than for the some-experience group. This means that ease of use is an important consideration by student teachers in the early stages of their IWB experience [21]. Other researchers extend the UTAUT with a new moderator variable, such as user type. For pre-adopters, social influence has a bigger impact on behavioral intentions. For post-adopters, the facilitating conditions have a bigger impact on the actual use of interactive whiteboards [22]. In different studies, the moderating factors have different effects, which may be relevant to the specific technical environment and research participants. Therefore, we analyze pre-service and in-service teachers' acceptance of AR technology from the perspective of gender and experience as shown in fig.1. According to this model, the hypotheses put forward are as follows.

H1: The pre-service teachers and in-service teachers affect the acceptance of AR technology through social influence (H1a), facilitating condition (H1b), performance expectation (H1c) and effort expectation (H1d).

H2: The teacher's gender affects the acceptance of AR technology through social influence (H2a), facilitating condition (H2b), performance expectation (H2c) and effort expectation (H2d).

H3: The teacher's experience affects the acceptance of AR technology through social influence (H3a), facilitating condition (H3b), performance expectation (H3c) and effort expectation (H3d).

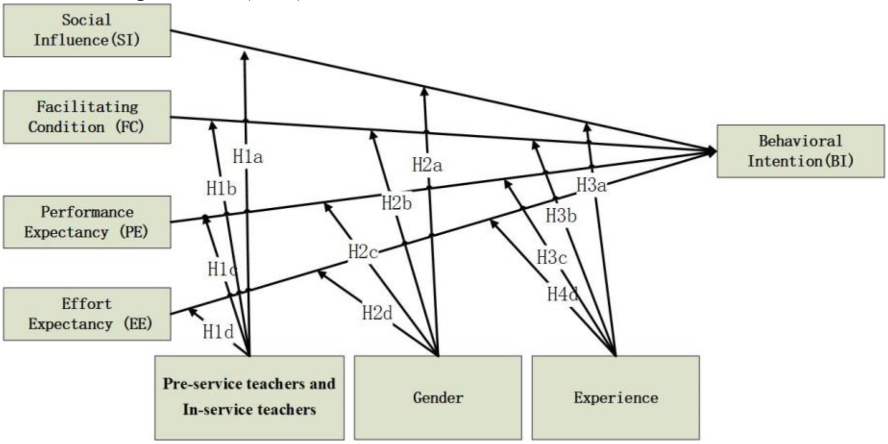

Fig. 1. Model in our study based on UTAUT

3 Method

3.1 Participants and Process

The participants of this study were 71 pre-service teachers (include one invalid questionnaire) and 50 in-service teachers. All the pre-service teachers are graduate students with teacher professional development training or got teacher certifications from the government. The in-service teachers came from different area in China. All the participant attended a two-hour lecture about AR and its role in education first, then filled a questionnaire.

3.2 Instrument

A questionnaire survey was used to investigate the pre-service and in-service teachers' acceptance of AR systems, which was adapted from reliable questionnaires shown in table 1. All the variables in the study were measured using a scale of 1 to 7 (1 = very strongly disagree to 7 = very strongly agree). In addition, the basic information of the participants was collected, such as gender and experience. For experience, the 7-point scale was used to investigate the teachers' experience in using AR systems.

Table 1. The Questionnaire of Technology Acceptance.

Dimension	Item	Reference
Social Influence	People who influence my behavior think that I should use AR in the teaching.	Workman, Michael. 2014[23]
	People who are important to me think that I should use AR in the teaching.	
Facilitating Conditions	I have the resources necessary to use AR in the teaching.	Workman, Michael. 2014[23]
	Instruction is available to help me use AR in the teaching.	
	I have control over using AR in the teaching.	
Performance Expectancy	Using AR technology is secure in the teaching.	Workman, Michael. 2014[23]
	Using the AR technology would make it easier to do my tasks in the teaching.	
	Using the AR technology is a bad/good idea in the teaching.	
	Using AR technology would enable me to accomplish my tasks more quickly in the teaching.	
Effort Expectancy	I have the skills to AR information technology.	Workman, Michael. 2014[23]
	Learning to use AR technology would be easy for me.	
	I would find it easy to get AR technology to do what I want it to do.	
Behavioral intention	I recognize this kind of AR	Venkatesh et.al2003[4]
	I would like to use this kind of AR in my teaching.	
	I would like to recommend this kind of AR to other colleagues.	

4 Results

There were 120 valid questionnaires in this study. They are 70 pre-service teachers (58%) and 50 in-service teachers (43%). There were 11 male and 59 female in the pre-service teacher, and 23 male and 27 female in the in-service teacher. In total, there are 34 male (28%) and 86 female (72%). There are 33 primary school and below teachers, 25 junior high school teachers, 40 senior high school teachers and 22 college teachers. They come from 38 information technology courses, 18 language courses, 15 STEM courses,11 math courses, 11 physics courses, 5 geography courses, 22 other courses (e.g. music, biology, chemistry, ideology and morality course and so on).SPSS 22.0 is used for data analysis. The Cronbach's Alpha system value of all the items is 0.956. Overall, the dimensions associated with behavioral intentions are social influence, facilitating conditions, performance expectancy and effort expectancy as shown in table 2.

Table 2. Correlation analysis of UTAUT's dimensions.

Spearman's rho	dimension			
	Social Influence	Facilitating Conditions	Performance Expectancy	Effort Expectancy
Behavioral Intention	0.401**	0.214*	0.832**	0.320**

*$p<0.05$, **$p<0.01$.

4.1 Pre-service teacher and in-service teacher

Differences Analysis of Pre-service teachers' and In-service Teachers' AR Technology Acceptance

Pre-service teachers and in-service teachers have significant differences on Social Influence ($t=-2.60$, $p<0.05$), Performance Expectation ($t=-2.62$, $p<0.01$), Behavioral Intention ($t=-2.32$, $p<0.05$). In-service teachers are superior to pre-service teachers in these respects as shown in table 3.

Table 3. Differences analysis of Pre-service and In-service teachers' AR acceptance.

	Social Influence		Facilitating Conditions		Performance Expectancy		Effort Expectancy		Behavioral intention	
	M	t	M	t	M	t	M	t	M	t
Pre-service teacher	5.04	-2.60*	4.62	-0.93	5.30	-	4.47	-1.20	5.55	-2.32*
In-service teacher	5.64		4.82		5.73	2.62**	4.76		5.94	

*$p<0.05$, **$p<0.01$.

The Correlation of Pre-service Teachers' and In-service Teachers' Behavioral Intention and Influencing Factors to AR Technology

For pre-service teachers, social influence, performance expectation, effort expectation are related to behavioral intention. Based on this, an effective regression model of pre-service teachers' technical acceptance ($F=32.827$, $p<0.001$) was constructed. The value of adjusted R^2 reached 0.58, indicating that 58% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.709* performance expectation +0.153* social influence +1.287.

For in-service teachers, social influence, performance expectation, effort expectation and facilitating conditions are related to behavioral intention. Based on this, an effective regression model of in-service teachers' technical acceptance ($F=44.616$, $p<0.001$) was constructed. The value of adjusted R^2 reached 0.78, indicating that 78% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.925* performance expectation.

4.2 Gender

Differences Analysis of Pre-service and In-service teachers' AR Technology Acceptance with different gender

Gender has significant on Social Influence ($t=2.67$, $p<0.01$) as shown in table 4. Male teachers are superior to female teachers in the social factor that influence the intention to use AR, who receive more support and encouragement from others.

Table 4. Differences analysis with different gender.

Pre-service and In-service teacher	Social Influence		Facilitating Conditions		Performance Expectancy		Effort Expectancy		Behavioral intention	
	M	t	M	t	M	t	M	t	M	t
Male	5.75	2.67**	5.02	1.94	5.27	-1.62	4.80	1.11	5.55	-1.2
Female	5.11		4.57		5.56		4.51		5.77	

*p<0.05, **p<0.01.

The Correlation of Pre-service and In-service Teachers' Behavioral Intention and Influencing Factors with Different Gender

For male pre-service and in-service teachers, social influence, performance expectation and effort expectation are related to behavioral intention. Based on this, an effective regression model of male teachers' technical acceptance ($F=32.428$, $p<0.001$) was constructed. The results showed that the effect of the predictive variable on behavioral intention was highly explanatory, while the value of adjusted R2 reached 0.741, indicating that 74.1% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.665*performance expectation +0.308*social influence.

For female pre-service and in-service teachers, social influence, performance expectation, effort expectation and facilitating condition are related to behavioral intention. Based on this, an effective regression model of female teachers' technical acceptance ($F=46.843$, $p<0.001$) was constructed. The value of adjusted R2 reached 0.683, indicating that 68.3% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.862* performance expectation + 0.842.

4.3 Experience in using AR

Differences Analysis of Pre-service and In-service Teachers' AR Technology Acceptance with different experience

According to the 7-point scale of experience item in using AR, the top 27% of teachers (33 people) were in the high experience group and the bottom 27% (33 people) were in the low experience group. Experience has significant on Facilitating

Condition (t=-7.33, p<0.001), and Effort Expectancy (t=-6.422, p<0.001). High-experience teachers are superior to Low-experience teachers in these respects as shown in table 5.

Table 5. Differences analysis with different experience.

Pre-service and In-service teacher	Social Influence		Facilitating Conditions		Performance Expectancy		Effort Expectancy		Behavioral intention	
	M	t	M	t	M	t	M	t	M	t
Low-experience	5.13	-1.860	3.70	-7.33***	5.43	-1.089	3.61	-6.422***	5.75	-0.265
High- experience	5.71		5.53		5.71		5.46		5.81	

*p<0.05, **p<0.01,***p<0.001.

The Correlation of Pre-service and In-service Teachers' Behavioral Intentions and Influencing Factors with Different Experience

For low-experience teachers, social influence and performance expectation are related to behavioral intention. Based on this, an effective regression model of low-experience teachers' technical acceptance (F=82.46, p<0.001) was constructed. The value of adjusted R^2 reached 0.836, indicating that 83.6% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.849* performance expectation.

For high-experience teachers, social influence, facilitating condition, performance expectation, and effort expectation are related to behavioral intention. Based on this, an effective regression model of high-experience teachers' technical acceptance (F=31.527, p<0.001) was constructed. The value of adjusted R^2 reached 0.792, indicating that 79.2% of the data was fitted to the model. Therefore, the regression equation is behavioral intention =0.264*performance expectation-0.427*effort expectancy.

5 Discussion and conclusion

In this study, we analyzed 70 pre-service teachers' and 50 in-service teachers' basic information and acceptance of AR technology. According to results, there are interesting findings that teachers of different gender and experience present different responses to behavioral intentions of AR and its determinants (performance expectation, effort expectation, social influence and facilitating conditions).

Pre-service teachers and in-service teachers had a significant influence on the relationship between the behavioral intention of AR and its determinants (H1a). For pre-service teachers, social influence and performance expectancy had statistically positive effects on behavioral intentions to use AR. For in-service teachers, performance expectancy had statistically positive effects behavioral intentions to use AR. This may because pre-service teachers are under pressure to find jobs. Therefore, they are willing to use AR, if the AR recognized by society. This verified Venkatesh's hypothesis [4], which were not found in the previous survey of ICT acceptance of preservice teachers [24].

For all the participants, gender has a significant effect on the relationship between social influence and behavioral intentions of AR (H2a). For the male teacher, social influence and performance expectancy had statistically positive effects on behavioral intentions to use AR. For the female teacher, performance expectation is the only significant factor influencing behavioral intentions to use AR in the regression equation. Therefore, for pre-service teachers and in-service teachers, male are more sensitive to social influences than female, which is consistent with two other studies [5], [19]. Therefore, if the teacher using AR is male, school leaders or teaching and research personnel should give them more support and encouragement.

For all the participants, experience has a significant effect on the relationship between Effort expectancy and behavioral intentions of AR (H3d). For low-experience teachers, performance expectancy had statistically positive effects on the intention to use AR. For high-experience teachers, effort expectancy also has a significant impact on behavioral intentions to use AR, but it is a negative impact, which is an interesting finding. This may because high-experience pre-service and in-service teachers prefer AR with certain difficulty. For them, the ease of use is inversely proportional to behavioral intentions in a way.

The limitations of the present study need to be noted. As the sample size of the experiment was not large, it might be imprecise to infer the findings to other cases. We did not research the influence of teachers' knowledge and skills in designing learning activities with AR on their acceptance. Consequently, several follow-up studies can be considered, such as how to improve different teachers' acceptance of AR. In the future, we plan to use different strategies in present AR to different teachers and not only improve their behavioral intention but also inspire them to use AR in instructional practice.

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Integrating Enhanced Peer Assessment Features in Moodle Learning Management System

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Abstract. Peer assessment has increasingly proven its benefits for the learning process and several educational platforms have been proposed to support it. Rather than developing yet another standalone tool, in this paper we aim to integrate an existing Bayesian Network-based peer evaluation approach in a widely used learning management system, Moodle. This allows to capitalize both on the successful peer assessment model and on the broad range of educational functionalities provided by the learning management system. More specifically, we start from Moodle Workshop plugin, which supports the management of peer assessment sessions, and extend it with several features: i) support for student modeling based on Bayesian Network approach; ii) various metrics regarding the reliability of the computed models; iii) enhanced visualizations and comparisons of learner models and session results. The paper describes the solution proposed for extending the plugin in terms of mechanisms, pedagogical rationale, implementation and functionalities.

Keywords: Peer assessment, Bayesian Network model, Student model, Moodle, Workshop plugin

1 Introduction

Peer assessment is increasingly popular in education, being supported by many platforms, templates and frameworks applied in various learning settings, ranging from primary school to higher education. Several benefits are stemming from the peer evaluation process for both learners and instructors. Students are able to compare and discuss their solutions with peers [5] and feedback improves performance, by re-directing learners' focus on significant aspects of their work [8], and by exposing them to different perspectives and ideas. Furthermore, the activities of *analysis* and *evaluation* fostered by peer assessment are related to high level metacognitive skills [2]. In addition, teachers also benefit from peer

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assessment, by enjoying a reduced and more focused evaluation workload; this is especially the case when peer assessment is used to create a learner model (allowing to spot students at risk) or when it is used to give grades automatically, with just some limited teacher input/calibration.

Peer assessment has started to be used also in learning management systems (LMS), including the popular and widespread Moodle platform [9]. The peer evaluation functionality is supported by means of an extension plugin called Workshop [13]; the module is based on sessions in which learners submit their own work and assess the work of peers according to the teacher's specifications. Our objective is to enhance Workshop module with student modeling capabilities, based on a Bayesian Network approach, as proposed in [6]; the basic proof of concept has already been presented in [1].

More specifically, in this paper we describe the solution proposed for extending the Workshop plugin, in terms of mechanisms, pedagogical rationale, implementation and functionalities. The main features provided by the enhanced plugin include: i) support for student modeling based on Bayesian Network approach; ii) various metrics regarding the reliability of the computed models; iii) enhanced visualizations and comparisons of learner models and session results. The plugin can be applied in online and blended educational learning settings to enhance the learning process and provide a more effective peer assessment environment both for students and instructors. To the best of our knowledge, no similar functionality has been developed for Moodle / Workshop plugin to enhance its student modeling capabilities.

The rest of the paper is structured as follows: in section 2 we provide an overview of related work and the frameworks we start from. In section 3 we describe the mechanisms used for enhancing the Workshop module and the way the extensions were implemented. In section 4 we illustrate the main functionalities offered to the students and to the instructor respectively. Finally, in section 5 we provide some conclusions and future research directions.

2 Related Work

As mentioned in the Introduction, several peer assessment systems have been proposed in the literature during the past years. For instance, *CrowdGrader* [5] is a tool for the evaluation of homework assignments based on crowdsourcing; *PeerStudio* [8] is an assessment platform supporting an integration of automated (algorithmic) grading and peer evaluation over large online classes, to enable rapid feedback and lower the amount of work required from the students; *SPARK* [7] is a web-based template which aims to improve learning through team assessment tasks and make fairer the evaluation of individual students in the team.

Sometimes peer assessment and automated grading of the student's work are combined, to enhance the evaluation precision and to reduce the teacher's grading burden as well [8, 14]. *CaptainTeach* [10], for example, is a programming environment where the intermediate stages of the assignments' production are enhanced by peer assessment. *CritViz* [12] is a web-based system supporting *peer critique*, allowing to organize peer review sessions in large classes, where learners' work cannot be assessed solely on objective criteria. As a further example, *Mechanical TA* [14] boosts the quality of students' assessments by letting the activity of currently less competent peer reviewers be aided by human teaching assistants.

Instead of proposing a standalone platform, as in related works, our aim is to integrate an existing peer assessment approach in a widely used learning management system, Moodle [9]; this would allow to capitalize on the broad range of educational functionalities provided by the LMS. More specifically, we start from a peer assessment framework called *OpenAnswer* (OA) that we proposed in [6]. With OA students participate in sessions, each one comprised of a question to be answered (*answer phase*) and a peer evaluation of the answers (*peer evaluation phase*). In each session the teacher is called to grade a part of the answers; both students' and teacher's grades are represented in a Bayesian Network, where a student model (SM) computation is managed. The SM consists in the student's proficiency in answering and her/his capability to assess peers' answers. The SMs are maintained along a sequence of sessions, and allow for fairly accurate automatic grading of answers that were not evaluated by the teacher. The results obtained with OA were very encouraging [6], therefore we decided to provide it as a web service, for easy integration with other educational platforms [1]. A corresponding Python-based API was also proposed for the Bayesian Network Service [1].

The provision of web services for educational peer assessment systems has also been reported in [11]; services for the computation of reputation, summarization and visualization are offered as part of the *PeerLogic* research project. As far as Bayesian Network models are concerned, their use for student modeling has been successfully investigated in the literature [3, 4]. Inspectable student models have also been proposed; *ViSMod* is a tool that allows learners and teachers to understand, explore and modify Bayesian Student Models, which are built including both cognitive and social features of the learners [15].

With respect to the integration in Moodle, we chose to start from the Workshop plugin, which supports the management of peer assessment sessions as course *activities* [13]. Furthermore, the concepts of student's work grade and grading capability are already available in Workshop, while the previously mentioned OpenAnswer phases could also be supported by the plugin features. However, Workshop does not support the management of a truly evolutionary student modeling, beyond the computation and visualization of the grades of a session, which is one of the enhancements we provide in this paper. Details regarding the integration and extension mechanisms are provided in the next section.

3 Mechanisms for Enhancing the Workshop Module

As mentioned before, Workshop is a plugin available in Moodle for defining and administering peer assessment sessions in a class. Basically the protocol is as follows:

1) The teacher creates a session by providing a task description and instructions for solution submission.
2) The teacher also defines the content of the assessment form that will be used by the students. This form includes assessment instructions and criteria that can be weighted.
3) When the submission phase of the session is open, the students can submit their task solutions (answers).
4) During the peer assessment phase, the submissions are assigned to peers, who can fill in the assessment form; the teacher may choose to fill in the assessment form as well.
5) Finally, the *grade report* (i.e., a table that summarizes the session results) can be computed and visualized. It shows, for each individual student, the solution grade and the *grading grade* (i.e., the measure of how close this student's peer assessments are to the actual grades received by the evaluated peers). The solution grade is computed based on the distribution of peers' (and possibly teacher's) assessments, using a weighting mechanism.

As stated in the Introduction, our aim was to refine the peer assessment process and enhance the student modeling capabilities available in Workshop module. To this end, we performed the following extensions to the plugin:

a) integrated a Bayesian Network Service, proposed in [1], for computing the student model
b) added the concept of *Student Model Reliability*, to help the teacher decide how much a model can be trusted to make effective conclusions about the competences of a given learner
c) enhanced the grade report with additional learner data and several graphical visualization features, to allow both the students and the teacher to monitor learner progress and compare it with peers.

Extensions a) and b) are explained in the remainder of this section, while extension c) is illustrated in the next section.

We start by describing the Bayesian Network Service (BNS) for student modeling based on peer assessment data, which we introduced in [1], starting from the OpenAnswer framework [6]. The data generated in each session (i.e., the peers' evaluations, the available teacher grades, and the grades inferable for the students' answers) are represented by a Bayesian Network (BN), where each student is rendered by means of a sub-network comprised of six variables. The variables are K (Knowledge: the student's competence), J (Judgment: the student's assessing capability), C (Correctness of the student's answer), and one G (Grade) for each of the peer evaluations on this student's answer (the default is three, but the number of peer evaluations is configurable).

The variables are valued as probability distribution over the [A, F] grade interval. They have dependencies on one another, expressed by Conditional Probability Tables (CPTs), which are a constituent factor of the BN processing. Whenever a peer evaluation is given on an answer, the corresponding G variable is set. Likewise, whenever a teacher's grade is given, the corresponding C variable is set (i.e., the teacher's grade is always assigned as the final answer's grade, independently of any other peer evaluations). By effect of the mentioned dependencies, these changes propagate in the BN, causing continuous adjustment of the variables' probability distributions. The dependencies are as follows:

1) J is made dependent on K by a P(J | K) CPT. The rationale is that producing an evaluation (i.e., performing critical assessment) is a more difficult task than just using one's knowledge to solve an assignment (as such activities belong to different cognitive levels [2]).
2) In addition, assuming to work in a cheating-free class (as we do), C depends on K as well, by a P(C | K) table.
3) Moreover, each G associated to an answer depends on the C values of that answer and on the J of the evaluating peer P(G | J, C).
4) Finally, P(K) is postulated as starting distribution of probability for K (i.e., a kind of expected state of the class at session start).

Summing up, BNS supports a teacher-mediated approach to peer assessment, where the teacher's grades on some answers are relied upon to make the C inferences, for the answers not graded by the teacher, more precise (i.e., more similar to what the teacher's grade would have been). The students' grades build the BN; then the teacher's grades allow to update all the variables, by evidence propagation, to update the student models (i.e., the tuple (K, J)), and ultimately to refine the automated grading. More details regarding the proposed BN model for peer assessment can be found in [6].

The integration of the model in Workshop plugin is depicted in Fig. 1. The BNS is exposed through a BNS API, and is used via the protocol of communication, between Moodle/Workshop plugin and the service. A PHP-based client using the BNS API was developed and integrated into the Workshop plugin; data is exchanged in JSON format, as described in [1].

Thus, the new workflow, for the extended Workshop module, is as follows:

1) The teacher submits a grade for an answer of her/his choice, or asks for the computation of the grade report
2) The students' assessments and the available teacher assessment are sent to the BNS, in order to compute the new student models and answers' grades. In this phase, also the current student models (namely, the set of K values) are sent to the service, so that the computation is based on previous information rather than start from scratch.
3) The answer returned by the service is composed of:
   a. The set of newly computed students' K, J and C values

b. The suggestion about the next best answer to grade; this is the answer that, if graded, would inject the highest amount of information into the network, allowing the largest increase in precision for the production of the next round of C values.

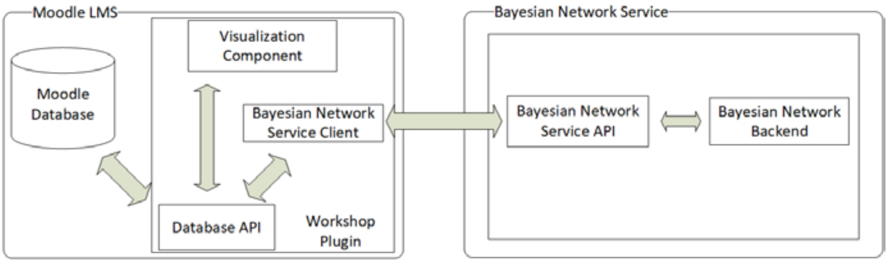


Fig. 1. Functional architecture of the enhanced Workshop plugin, including its interaction with the BNS implementing the OpenAnswer student modeling mechanism. (New tables were added in the Moodle database, to accommodate student data such as K, J and C).

A further enhancement of the Workshop plugin consists in the integration of the concept of *Reliability* of a student model. Skipping peer assessment sessions or having a fluctuating performance are factors that might reasonably weaken the effective representation of the student by the model. We therefore introduce the above factors, *Continuity* and *Stability* respectively, and define *Reliability* as the measure combining them.

Continuity depicts the frequency of students' participation in peer assessment activities. A high continuity value means the student was motivated and engaged during the semester, while a low value means the learner skipped sessions and was less actively involved. In order to compute continuity, each session is assigned a weight, depending on when the session was held (i.e., the first session has the lowest weight, the second has twice as much, the third has three times as much as the first, and so on); the student's continuity is the sum of the weights of the sessions in which (s)he participated, divided by the sum of all session weights (computed as a percentage).

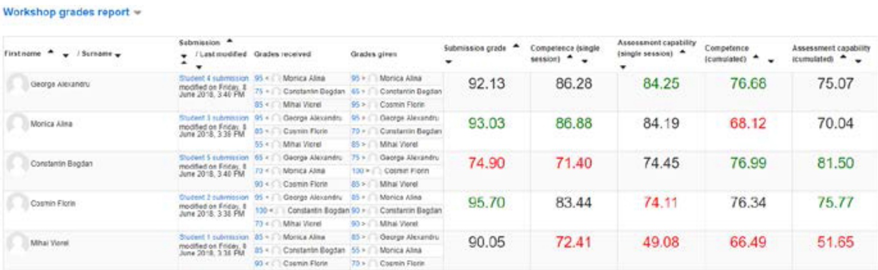
Stability measures the variation of the student's achievements over the sequence of sessions. It is computed based on the standard deviation of the student's submission grades: *stability(student) = 100 – std_dev(student's submission grades)*.

Reliability, then, is computed as a combination of the above measures, and labels the level of trust we can have in the model computed by the system. As continuity is considered more important than stability, they were given slightly different weights, as follows: *reliability(student) = continuity(student)*0.6 + stability(student)*0.4*.

4 Illustrating the Use of the Enhanced Workshop Module

4.1 Teacher Functionalities

An important functionality provided by the enhanced workshop module is the *Session Grades Report,* which brings additional features with respect to the original plugin (Fig. 2). Thus, the teacher can visualize the grades computed by the BNS for each student submission, as well as the student model data, in terms of Competence and Assessment capability. These values are computed by the BNS both based on current session data only (i.e., "single session") and based on all previous sessions ("cumulated"), providing a more comprehensive perspective of students' performance.



Workshop grades report

First name / Surname	Submission / Last modified	Grades received	Grades given	Submission grade	Competence (single session)	Assessment capability (single session)	Competence (cumulated)	Assessment capability (cumulated)
George Alexandru	Student 4 submission modified on Friday, 8 June 2018, 3:40 PM	95 < Monica Alina 75 < Constantin Bogdan 85 < Mihai Viorel	95 > Monica Alina 65 > Constantin Bogdan 95 > Cosmin Florin	92.13	86.28	84.25	76.68	75.07
Monica Alina	Student 3 submission modified on Friday, 8 June 2018, 3:38 PM	95 < George Alexandru 83 < Cosmin Florin 55 < Mihai Viorel	95 > George Alexandru 70 > Constantin Bogdan 85 > Mihai Viorel	93.03	86.88	84.19	68.12	70.04
Constantin Bogdan	Student 5 submission modified on Friday, 8 June 2018, 3:40 PM	65 < George Alexandru 70 < Monica Alina 90 < Cosmin Florin	75 > George Alexandru 100 > Cosmin Florin 85 > Mihai Viorel	74.90	71.40	74.45	76.99	81.50
Cosmin Florin	Student 2 submission modified on Friday, 8 June 2018, 3:38 PM	95 < George Alexandru 100 < Constantin Bogdan 70 < Mihai Viorel	85 > Monica Alina 90 > Constantin Bogdan 90 > Mihai Viorel	95.70	83.44	74.11	76.34	75.77
Mihai Viorel	Student 1 submission modified on Friday, 8 June 2018, 3:38 PM	85 < Monica Alina 85 < Constantin Bogdan 90 < Cosmin Florin	85 > George Alexandru 55 > Monica Alina 70 > Cosmin Florin	90.05	72.41	49.08	66.49	51.65

Fig. 2. Teacher interface: the enhanced Workshop *Grades Report* for a session. The two columns labeled "single session" report the K (competence) and J (assessment capability) for each student, based only on the data of the current session. The two columns labeled "cumulative" show the K and J computed when the BN was initialized with the K values coming from the previous session.

The *Session Grades Report* also shows the peers who evaluated the current student (in column 3), as well as those evaluated by the current student (in column 4). All columns in the report support a sorting functionality: ordering the table, with respect to a metric of interest, allows for good analysis opportunities. Furthermore, to better point out peers' proficiency levels, the figures are color-coded, with red used for the lower values (first quartile) and green for the higher values (fourth quartile).

One additional information coming from the BNS is about the *next best answer to grade* for the teacher; this is the answer whose grading would add the highest possible amount of information in the Bayesian Network, the next time the BNS is called. This information is provided by the module as a suggestion to the teacher; when and if the teacher wishes to add a grade, (s)he decides whether to follow the suggestion or not, and selects the next answer by her/himself.

The enhanced module also provides statistical information regarding mean and standard deviation of the answers' grades in a session or their evolution throughout the semester (see Fig. 3). This information can be quite relevant to the teacher, as it can be used to make determinations about the soundness or difficulty of the session's question, about its balancing with other sessions, and about the quality of the assessment instructions provided by the question.

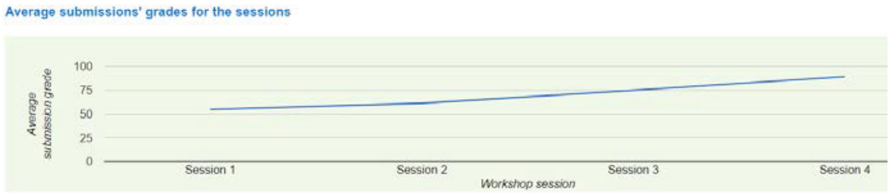


Fig. 3. Teacher interface: average submission grades for each session (evolution over time)

More detailed information regarding all the sessions available at course level is provided in a *General Grades Report* (Fig. 4). Here the teacher can visualize each student's average submission grade (over the sessions), the current cumulated model (*Competence* and *Assessment Capability*) computed after the last session attended by the student, and also the *Reliability* measure for this model, which is in turn computed as a linear combination of the other two measures shown in the report, *Continuity* and *Stability*.

General grades report

Name	Submission Grade	Competence	Assessment Capability	Continuity	Stability	Reliability
Mihai Viorel	71.53	66.49	51.65	100.00	67.33	86.93
Constantin Bogdan	73.69	76.99	81.50	100.00	62.54	85.02
George Alexandru	74.85	76.68	75.07	100.00	64.52	85.81
Monica Alina	75.18	68.12	70.04	100.00	65.66	86.26
Cosmin Florin	76.97	76.34	75.77	100.00	65.37	86.15

Fig. 4. Teacher interface: the *General Grades Report* provided by the enhanced plugin

4.2 Student Functionalities

The students have access to various information regarding their personal performance, as well as comparisons with the rest of the class. Data can be shown both at session level and at course level (i.e., based on the whole sequence of sessions), just as in case of the teacher.

At session level, the students can see their submission grade, as well as their competence and assessment capability scores (Fig. 5).

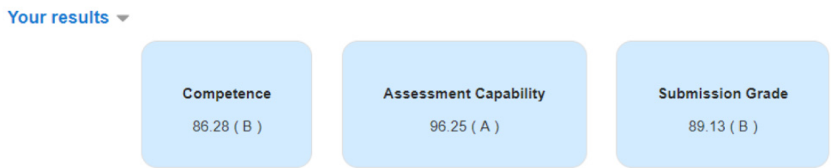


Fig. 5. Student interface: scores related to the current session

The learners can also visualize their ranking within the class, and a comparison with their previous session scores (Fig. 6). The students can thus monitor their progress, tracking their evolution throughout the sessions relative to their peers.

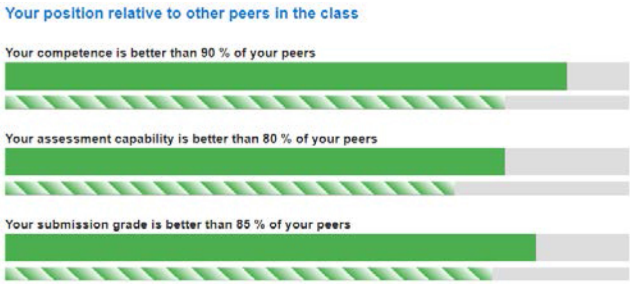


Fig. 6. Student interface: ranking within the class and comparison with previous session. The solid green bar represents the student performance position within the class (grey bar) in the current session; the hatched green bar depicts the same performance state in the previous session.

A similar dashboard is provided to the students at course level, including data aggregated along the sessions: cumulated competence and assessment capability, average submission grade, overall ranking within the class. A graphical representation of the evolution of student's scores throughout the semester is also provided (Fig. 7).

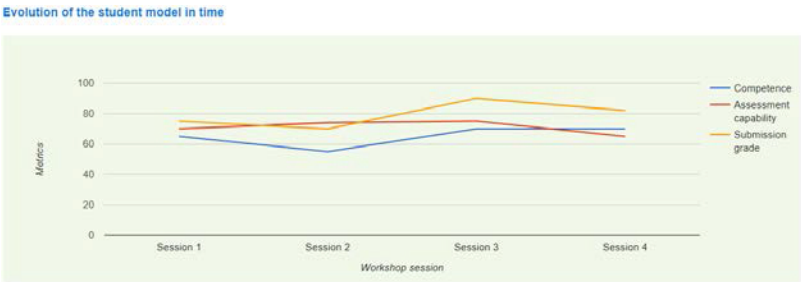


Fig. 7. Student interface: evolution of scores over the sessions

5 Conclusions

In this paper we presented an approach for extending Moodle with enhanced peer assessment functionalities. We showed how a Bayesian Network Service was integrated with Workshop plugin and how the module was extended with open learner model visualization features. These functionalities could help both the students, to monitor their progress and compare it with peers, and the teacher, to visualize grade reports, analyze peer assessment sessions and decide on the answers which would benefit most from her/his evaluation.

As future work, we aim to use the plugin in real world settings in order to experimentally validate our approach. A pilot evaluation is planned to be performed at Sapienza University of Rome, Italy, in a course on Programming Techniques taught to first year bachelor students in Computer Engineering; results will be reported in a future paper.

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Investigation Report on the Status and Needs of Beijing Citizens for Lifelong Learning

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Abstract. With the fierce competition in society, the acquisition of knowledge is no longer just through school education, but through continuing education. In the 21st century, the whole world is advocating lifelong learning. China is also making efforts. Beijing, as the capital of China, its citizens' lifelong learning status are directly related to the construction and development of Beijing's lifelong education system. This study used a questionnaire survey method, and used stratified sampling to extract 1,597 people from all districts in Beijing. The purpose of the study was to investigate the current situation, needs and difficulties of adult lifelong learning in Beijing, to explore the general situation, differences and analyze the affect factors based on the survey results. We hope the conclusions and suggestions of this study can provide relevant policy references and guidance for the Beijing government , Adult Education Society and other units.

Keywords: Beijing citizens; lifelong learning; learning status; learning needs.

1 Introduction

The 21st century is an era of learning for all and lifelong learning. [1] [2] Life-long learning has become the focus of attention in the era of knowledge-based economy. [3] [4] [5] According to the series of guidelines and policies marks the development of lifelong education in China, We must attach importance to the establishment of a life-long education system. [6] [7]

The purpose of this research is by investigating the current situation, needs and existing problems of Beijing citizens' lifelong learning, to analyze the data in a targeted manner and give corresponding countermeasures and suggestions based on the research results, which provides the theoretical basis and policy orientation for the construction of Beijing's learning society and the construction of a lifelong system.

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2 Research methods and design

2.1 The overall research framework of the project

The first stage: the questionnaire dimensions and the specific item determination stage. On the basis of defining the research questions, this stage studies the literature about the concept and connotation of “lifelong learning” and the questionnaires related to “lifelong learning status”, and forms the “lifelong learning status” questionnaire dimensions[8].Then it was revised by the expert Delphi survey, and finally formed the five first-level dimensions.

The second stage: test and revision of the questionnaire stage. At this stage, the test and revision of the questionnaire were conducted on the basis of the evaluation index system of “lifelong learning status”. Finally, based on the results of the two rounds of tests, the relevant topics of the questionnaire were monitored, revised and adjusted.

The third stage: the investigation implementation phase. The formal questionnaire was conducted from September 6, 2017 to October 20, 2017. The questionnaire was in the form of a paper version and was filled in by the researcher on site to enable it to be recovered in the shortest possible time.

The fourth stage: statistical analysis of data and summary of research results. At this stage, the collected questionnaires and topics are coded, statistical analysis software is used for data statistics, and the characteristics of “lifelong learning status” of adult citizens in Beijing and the differences in lifelong learning status between different groups are analyzed.

2.2 Research methods

This study used literature research and questionnaire survey methods. Through the investigation of related lifelong learning literature, the questionnaire of “Citizens' Lifelong Learning Status and Needs” was constructed, and a certain number of samples were selected to conduct a preliminary test on this questionnaire, and its validity and stability were measured to form a final questionnaire. According to the final questionnaire, the residents of 16 districts and counties in Beijing were selected for sample survey and this study defines the surveyed population as adults over 18 years of age.

2.3 Research tools

The self-developed questionnaire was used to investigate the status quo and needs of citizens' lifelong learning. The questionnaire consists of two parts: personal basic information and questionnaire scale questions, which covers 88 items in five dimensions. We invited 6 experts and 8 research assistants from Beijing Normal University, Beijing University of Posts and Telecommunications, Beijing Institute of Technology, and Capital Normal University to verify the content validity, and select a certain number (about 50) of the sample to conduct two pre-test tests to test the reliability of the questionnaire. The final version of the questionnaire adopted the recommendations of six experts and was identified as 108 items.

2.4 Statistical tools

Using Statistical Package for Social Science (spss19.0) data collected for statistical analysis, the outcome.

3 Research result

The research results of this study can be roughly divided into four aspects: the basic information characteristics of the sample, the overall situation of lifelong learning status of Beijing citizens, the differences in lifelong learning status between different groups, and the factors affecting the lifelong learning effect of citizens. The specific results are as follows.

3.1 Distribution of characteristics of effective sample groups

This study conducted a survey of the lifelong learning status of Beijing residents in 16 districts and counties. 1597 questionnaires were collected, and 1584 questionnaires were valid. The effective rate was 99.2%. After preliminary analysis of valid samples, the group characteristics were obtained. Here's the sample background information: the districts and counties where the samples are located are mainly concentrated in Fengtai, Fangshan, Tongzhou, Pinggu and Miyun districts; the distribution is biased towards urban areas; from the gender perspective, women account for 65.3%, males account for 32.4%; The proportion of the young group (under 44 years old) and middle-aged and older people (45 years old and older) is the same

3.2 General Situation of Lifelong Learning Status of Beijing Citizens

(1) Study time and study expenses

In the survey, only 12.2% of the citizens study more than 10 hours a week. Taking the day as a unit of measurement, most of the citizens can study for no more than one hour per day and have less time to study. And the full-time group has a longer learning time than the retirement and unemployed groups, so the government needs to propose mechanisms to encourage them to increase learning time. Based on the study expenditure and individual annual income, most of the citizens have less investment in learning funds every year, accounting for about 3.33% of their annual income.

(2) The understand of lifelong learning

98.3% of people have a positive attitude towards lifelong learning, 98.7% think that lifelong learning is beneficial to personal development and family life, and 97.1% can actively participate in community organization learning activities.

(3) Learning motivation

The main motivations for Beijing citizens to participate in various lifelong learning activities include maintaining the flexibility of brain thinking (96.6%), improving their competitiveness, not being eliminated by society (95.5%) and enriching their leisure time. Life (95.2%).

(4) Learning style

The most popular learning style of Beijing citizens is the combination of face-to-face teaching and online learning (92%). people like to use the smart phone to search the Internet.

(5) Learning place

In the choice of learning places, in accordance with the learning style, learning in their own home (93%), learning in the network environment (92.2%), learning in the training center (91.3%) is the most important lifelong learning place for Beijing citizens， in order to support online education that combines online and offline.

(6) Learning needs

At present, the most important learning needs of Beijing residents are free learning activities (96.9%), family life (more practical) courses (96.5%), and diverse learning methods (online and offline). Way) (96.4%).

(7) Learning difficulties

The lack of practical courses (92.1%), lack of time, energy (90.2%), and expensive study expenses (86.9%) are the most important difficulties faced by Beijing citizens in lifelong learning.

3.3 Differences in the status quo and needs of lifelong learning among different groups

(1) Lifelong learning in urban and rural residents

The residents' residential areas were investigated in detail according to the geographical divisions of “urban area”, “urban and rural areas”, “rural community” and “rural”, in order to analyze the residents of different areas of 7 dimensions.

In order to reasonably analyze the data, this study classifies urban areas and urban-rural areas as urban areas, and rural community and rural as rural areas. The statistical results showed that the significant P values corresponding to the dimensions of the understanding of lifelong learning, learning mode and learning effect were all less than 0.05, indicating that there were significant differences between urban and rural residents in these aspects. Combined with the descriptive statistics (mean), it can be seen that the overall level of lifelong learning, learning style and effect of urban residents is higher than that of rural residents.

(2) Residents in different age level groups (young people under 44 and middle aged and elderly people over 45 years old)

The statistical results showed that there was no significant difference in learning motivation between young people and middle-aged and elderly people, which may be because the young people had great pressure in work and life and did not have much time and energy for lifelong learning.

(3) Study time and costs between young and middle-aged and elderly groups

There is a significant difference in learning time and cost between the young and middle-aged and old groups. The youth group studies 4-6 hours per week, while the middle-aged group is concentrated in 2-4 hours; the annual learning cost of the youth group is 1000 yuan, while the middle and old age groups is about 500. This shows that the youth group has more energy and money investment.

(4) Learning content between young and middle-aged and elderly groups.

In the survey, 66.2% of the young people and 71.8% of middle-aged and elderly people participate in some learning activities. According to the study content * age cross table, young people tend to choose English, fitness, computer, training and flower arrangement from the most to the least. The training courses are literature, business, education, history. The choices of interest classes for the elderly are health knowledge, computer, singing, fitness, common diseases and prevention for the elderly, dance, handicraft, flower arrangement and English. The training courses are literature, history, education and psychology.

(5) Residents of different educational levels at different dimensions

Statistics show that there are significant differences in learning status and demand. According to the descriptive statistics, the higher the degree, the deeper the knowledge of lifelong learning, the more learning methods, the better the learning effect, the more satisfied I am with my own learning, and the more difficulties and demands that come with it. At present, the whole society is advocating lifelong learning, and the education level is proportional to each dimension.

(6) Residents with different occupations in different dimensions.

Statistics show that the lifelong learning status of different occupational status groups is different, among which the full-time group and unemployed group are significantly higher. With the continuous development of the society, the competition in various occupational fields is increasing. The unemployed group is in the uncertain state of professional life. In order to improve own quality and get better opportunities, they have a stronger demand for learning.

4 Conclusion

Generally speaking, although all districts and counties in Beijing have initially formed a good atmosphere for lifelong learning, rural residents, low educational background, low income, unemployed groups and other groups have more learning difficulties, and there is no good lifelong learning environment in rural areas. The preferred learning mode for citizens is the combination of face-to-face teaching and online learning. At the same time, due attention should be paid to reducing and eliminating the cost of lifelong learning and highlighting practical courses. For the elderly, face-to-face teaching should be increased, and graphic teaching methods should also be properly improved.

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Learning to Use the Fitness Equipment: Development and Evaluation of a Context-aware System with iBeacon Technology

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Abstract. To further study the context-aware learning approach, the current study, based on the technology of iBeacon and WeChat "Shake Nearby", built a context-aware learning system on fitness equipment and fitness knowledge. The study designed a controlled experiment and related interviews to evaluate the effectiveness and superiority of the context-aware learning. Results showed that the experimental group learning by the context-aware system had a high level of technology acceptance, and a slightly higher level of learning grades and learning motivation and a slightly lower level of the cognitive load than the control group. It could be seen that context-aware learning could help students study fitness equipment using and fitness knowledge more effective and pleasant than ordinary paper study materials.

Keywords: Context-aware learning · iBeacon · Cognitive load · Learning motivation · Fitness equipment

1 Introduction

Context-aware learning is an innovative approach that integrates wireless, mobile, and context-awareness technologies to detect the situation of learners in the real world [1]. Many researches had indicated that context-aware learning approach could benefit learner in several knowledge domains. With a context-aware learning system, the students' learning achievements had been significantly improved in a senior high school Geosciences course [2]. Indeed, some researchers had indicated that context-aware technology could help learners to effectively acquire language-related knowledge [3][4].

iBeacon is an alternative power-based positioning system based on Bluetooth low energy (BLE) technology which was developed by Apple in 2013. Applications can be built to cause events to be triggered within an instant of a device coming within the detectable range of the beacon [5]. "Shake Nearby", introduced in 2015, is an

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O2O (Online to Offline) function of WeChat based on BLE. It lets users connect with the surrounding environment by shaking their phone. When the users are within the signal range of the iBeacon station, open WeChat and shake, the nearby information will be pushed to the smartphone.

To further studying the context-aware learning, this study developed a context-aware system about the usage of fitness equipment and related knowledge based on iBeacon and WeChat "Shake" and evaluated the effectiveness of this context-aware system compared with paper masteries by experiment and interview.

This study proposed four research hypotheses:

1) After onsite learning of fitness equipment, the learning effectiveness of the experimental group using the context-aware learning system was significantly higher than that of the control group using paper materials;

2) After onsite learning of fitness equipment, the learning motivation of the experimental group was significantly higher than that of the control group;

3) After onsite learning of fitness equipment, the cognitive load of the experimental group was significantly lower than that of the control group;

4) The learner of the experimental group could accept the context-aware learning system and grasp the operational method quickly.

2 System Design

The current study selected three types of fitness equipment, namely leg curling, curl-up board and high-pull training combination, and designed learning content for each of the three kinds of fitness equipment.

The learning content was text, supplemented by vivid pictures and animated GIFs. Each fitness equipment's learning content included two Parts. Part 1 consisted of relatively basic methods of using fitness equipment, including involved muscle, action explanation, motion track, breathing rhythm, and proper training program. Part 2 consisted of advanced fitness knowledge, shown in several knowledge points. The detailed learning content was composed by the professional fitness instructor. The pictures and animations on the page were taken in the field. **Fig. 1.** is part of learning content.

The iBeacon base station was deployed next to the selected three fitness equipment. The model number of iBeacon base stations was nRF51822. WeChat's "Shake Nearby" function was implemented using WeChat public platform, and then configured iBeacon base stations according to the UUID, Major, and Minor parameters. Those three parameters are the key to match between the iBeacon station and pop-up page. A link for popping up the learning content interface was embedded for each base station. The service page that the user shakes out was based on HTML5. When the user turns on the phone Bluetooth, move close to the fitness equipment, and opens WeChat "Shake", a "Nearby" button will appear in the lower left corner. At this time, by shaking the mobile phone the link of the learning content webpage will pop up.

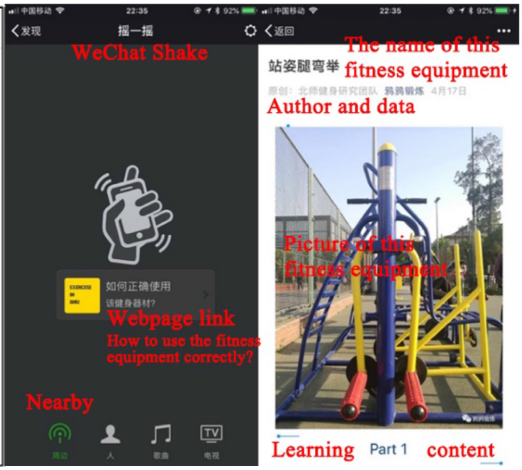

Fig. 1. Learning Content **Fig. 2.** User Interface

3 Method

Thirty college students were recruited. They were randomly divided into two groups, the experimental group and the control group. Each group had fifteen participants and an equal ratio of males and females. They were not major in Sports-related Subjects or fitness enthusiasts.

An experiment and interviews were carried out in this study. Experimenters guided each participant to learn the usage of fitness equipment and fitness knowledge and collected feedback through the pre-post test questions and learning experience questionnaire. **Fig. 3.** is the detailed experimental procedure. The content of the context-aware learning system was the same as the paper materials except that the GIF animation was replaced by a picture on the paper materials.

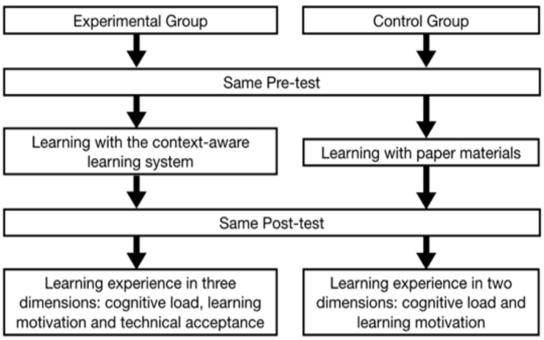

Fig. 3. Experimental Procedure

Detailed feedbacks were collected in the interview. Six learners were selected from two groups (3 learners each) following the purposive sampling principle and carried out a semi-structured interview.

Pre-posttest. The pre-posttest followed the principle of homogenization as much as possible. Pre-tests showed that there were no significant differences between the pre-test items and post-test items. The Cronbach's alpha values were 0.869 and 0.778, and the difficulty coefficients were 0.545 and 0.533, and the expert reliability was 0.80.

Cognitive load questionnaire. This questionnaire was based on the theory of Paas and Sweller, and van Merriënboer, and Paas. The Cronbach's alpha values for the two parts were 0.86 and 0.85.

Learning motivation questionnaire. This questionnaire was adapted from Hwang and Chang [6]. The Cronbach's alpha values for both parts were 0.79.

Technology acceptance questionnaire. This questionnaire was based on the research of Chu, Hwang, Tsai, and Tseng [7]. The Cronbach's alpha values of the two parts were 0.94 and 0.95.

4 Results

Analysis of Learning Effectiveness. The average score and standard deviation of the pre-test of the experimental group were 13.13 (out of 28) and 2.386, and that of the control group were 16.07 and 3.150. The results of the T-test ($t=-3.232$, $p=0.006<0.05$) indicated that there was a significant difference in the pre-tests between the two groups, so the knowledge level of the two groups of learners before learning could not be considered homogeneous.

Researchers used the ANCOVA covariance analysis to test the difference between the two groups. The pre-test score was used as the covariate and the post-test score was used as the dependent variable. After the adjustment, the average score and standard deviation of the experimental group was 19.578 (out of 28) and 1.577, and that of the control group were 20.222 and 1.577. According to the results ($F=0.074$, $p > .05$), there was no significant difference between the two groups.

Analysis of Learning Motivation. The mean and standard deviation of the control group were 4.719 (out of 6) and 0.730, and that of the experimental group were 4.867 and 0.619. The T-test results ($t=0.498$), $p > .05$) showed no significant difference in learning motivation between the two groups.

Analysis of Cognitive Load. The mean and standard deviation of the cognitive load of the experimental group were 1.92 (out of 6) and 0.645, and that of the control group were 2.07 and 0.932. The T-test results ($t = -0.521$, $p < 0.05$) showed that the cognitive load had not significantly different between the two groups.

Analysis of Technical Acceptance. The average value of technology acceptance was 5.067 (out of 6). It indicated that the experimental group learners believed that the context-aware learning system could play a positive role in their learning.

4.1 Analysis of Interview

Learning effectiveness. Learners have given positive feedback similar to “yes” and “can understand” in learning how to use fitness equipment only by learning materials. It could be seen that whether the experimental group or the control group, the learner could master the basic usage of the fitness equipment.

Learning motivation. All the interviewees were curious about the fitness equipment and they thought it was helpful and useful to know fitness knowledge. It could be seen that their learning motivation was at a high level. The interviewees of the experimental group also said that with the help of the context-aware learning system, they would use the fitness equipment and learn relevant fitness knowledge more frequently and even make an exercise plan after learning. The context-aware learning system has played a positive role in improving learner’s motivation.

Cognitive load. Learners from both groups all reflected that “the learning process is very easy” and “very simple”, and “the learning materials are very clearly”. It could be seen that the cognitive load of the learning process was at a low level and the learning materials were simple and easy to understand. Some learners also said that animated GIFs in the context-aware learning system did make learning easier.

Technology acceptance. The experimental group learners all said that the context-aware learning system was “very convenient” and “no problem in operation”. It was shown that the context-aware learning system had high technical acceptance and learners could easily accept and grasp the operation method quickly.

5 Discussion and Conclusion

Based on iBeacon and WeChat “Shake”, this study developed a context-aware learning system for learning the usage of fitness equipment and related fitness knowledge. The effectiveness and superiority of the context-aware learning system was verified through an experiment and interviews.

Hypothesis 1: There was no significant difference in learning scores between two groups. which did not support the hypothesis 1. The learning effectiveness of the experimental group had more progress than the control group. It is believed that the learning tasks in this experiment were too simple, resulting in a “ceiling effect”[8]. Considering that actual operation is vital to learn using fitness equipment, therefore, knowledge test papers play a limited role in testing learning results. Interview results showed that the context-aware learning system can provide better guidance for learners to a certain extent.

Hypothesis 2: The learning motivation showed no significant difference between two groups, which was against the hypothesis 2. It is believed that learning the usage of fitness equipment and operating fitness equipment were very interesting tasks, so the curiosity of the learners could be satisfied. In the case of high original learning motivation, the effect of the context-aware learning system on learning motivation was not very obvious. Interviewees emphasized that context-aware learning system was more convenient and more interesting than paper materials, and was an ideal learning tool. By providing a better learning way, to a certain extent, the context-aware learning system can improve learner's motivation indirectly.

Hypothesis 3: There was no significant difference in cognitive load between two groups, which did not support the hypothesis 3. It is believed that the learning tasks in the experiment were simple and small, which caused the "ceiling effect" [8]. Most of the interviewees indicated that the cognitive load was low. This confirmed that the difference in cognitive load between the two groups was not significant due to the over-simplicity of the learning task. The interviewees in the control group also stressed that the paper learning materials were very boring, and they hoped to learn with oral statements or short videos.

Hypothesis 4: From the database of the experiment, the technical acceptance value of the experimental group was at a high level, conformed to the hypothesis 4.

In conclusion, the experiment results show that the experimental group learning by the context-aware system had a high level of technology acceptance, and a slightly higher level of learning grades and learning motivation and a slightly lower level of the cognitive load than the control group. It can be seen that the context-aware learning system can help students learn fitness equipment using and related fitness knowledge in a more effective and pleasant way.

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Library Makerspaces and Connected Learning to Advance Rural Teen Creativity

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Abstract. This paper addresses the problems rural libraries and information centers have in attracting and serving teens. It discusses the changing demographics of teens, continued impact of learning technologies, teens' lack of adequate preparation for the workforce, the importance of connected learning, and the need for interactive learning opportunities for youth. The difficulties of reaching youth in rural communities can be addressed by developing training, creating makerspace models, and producing connected learning activities for teens.

Keywords: Makerspaces · Connected · Learning · Library Services · Teens · Rural Education

1 Introduction

The 2014 White House Maker Faire initiated Makespace Movement that promotes innovation and invention through the use of computers, 3-D printers, and traditional arts and crafts supplies. However, in rural America, which is defined by US Census as small cities with 2500 or less, both human and learning resources are not adequate comparing to urban and suburban peers due to low level of social and economic status and infrastructure investment. Makespaces are attractive to teens, who are one of the most difficult social groups to reach out in rural public education. In 2014, the Young Adult Library Services Association (YALSA) stated: "Library services and resources for teens are in jeopardy. Recent economic downturns have negatively affected library services, particularly those provided for youth."[1]

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2 Analyzing Difficulties on Serving Rural Teens

2.1 Shift in Demographics

According to the 2010 census, there were 74.2 million children under the age of eighteen in the United States. Twenty two percent of children lived in families with incomes below the federal poverty level. The number of unemployed youth ages 16-24 was at an all-time high of twenty-two point seven percent. About 3 million teens a year drop out of school. More than 1.3 million children and teens experience homelessness each year.

2.2 Impact of Technology

Rapidly changing technology combined with the proliferation of digital devices impact the ability of library staff to help teens. Many people make the mistake of thinking teens don't need adult help when it comes to technology. While teens are often referred to as "digital natives," research shows that many teens are no more savvy about technology, digital media, or the web than adults.[2] Yet digital-literacy skills are critical for completing homework, applying for a job, accessing government online resources, applying to college, being successful in the workforce, contributing to the democratic process, communicating with peers—the list goes on.[1]

A related concern is the younger generation has become a nation of consumers, not creators. Teens know how to use devices and apps, but not how to create new technologies or write computer programs. This lack of knowledge extends to more traditional technologies such as soldering, sewing, woodworking, pottery, and mechanical devices. With the rise of computer science, many schools discontinued classes such as home economics and shop classes, which resulted in teens not understanding how things are made, how they work, or how to create new things.

3 Solution: Training, Makerspaces, Connected Learning

3.1 Training of Rural Educators and Librarians

A wealth of information exists on ways to attract and serve teens. Research on the needs, behaviors and demographics of teens is extensive. Providing easy to understand on-demand training for library staff will enable rural librarians to better serve teens, a difficult-to-reach segment of their community. The training topics may include how to attract teens, effective ways to interact with teens, the changing demographics of the teen population, workforce skills teens need, connected learning goals and techniques, and inquiry based educative activities.

3.2 Makerspaces

A collaborative creation space, or makerspace, can give teens a place where they can hang out while working in a group, can experience hands-on learning, and practice life skills in an informal setting. It can provide access to equipment and materials they can use to create and develop technical skills. According to Dale Dougherty of Make Media, "These places, called Makerspaces, share some aspects of the shop class, home economics class, the art studio, and science labs. In effect, a Makerspace is a physical mash-up of different places that allows makers and projects to integrate those different kinds of skills."[3]

Makerspaces can provide opportunities for teens to develop critical thinking skills, digital literacy, and practice practical hands-on skills. Makerspaces have meaningful implications for a new generation of inventors and innovators, as recently there has been a drive toward "interdisciplinary collaboration in industry, which requires informational and physical connectivity."[4] This is particularly important for teens. They need the opportunity to develop critical thinking skills, technical expertise, and confidence in order to be better prepared to enter the workforce and with, more productive lives.

Research shows makerspaces are valued as community engagement spaces in rural communities. Residents of small rural communities described few opportunities to gather, to learn from one another, or to work together. Having a space where teens can gather and practice collaborative creation can help fill a void in the lives of many rural teens. Makerspace tools are interesting and exciting, and often considered as important as the act of collaborative creation and knowledge building.[5]

3.3 Connected Learning Activities

The Maker Movement, as it is currently being realized and branded, might be grouped into three categories: making as entrepreneurship and/or community creativity, making as STEM pipeline and workforce development, and making as inquiry-based educative practice.[6] In early 2013 the Connected Learning Research Network (CLRN) published their report, Connected Learning: An Agenda for Research and Design. At the heart of connected learning is the idea that young people learn best when that learning is connected to their passions, desires, and interests.[7] The principles of connected learning call for a shift from professional library staff as the focal points of all knowledge to a model in which the library makes it possible for skilled people around the world, either physically or digitally, to support teen needs by providing coaching, mentoring, and hands-on opportunities for learning.[1]

By developing easy to implement activities for teens to do in a makerspace that incorporates inquiry based educative practices and connected learning, public libraries and information professions can offer teen program activities that will:

- inspire interest
- foster working collaboratively
- develop understanding of manufacturing processes
- learn design and testing concepts
- promote innovation
- and encourage creative thinking.

These programs will support teens' development of identities as thinkers, creators, and producers of knowledge.

4 Conclusion

The problems rural librarians have in reaching youth in their communities can be addressed by developing training, creating makerspace models, and producing connected learning activities for teens. Library staff will be able to provide meaningful, quality service and programs to this hard to serve segment of their community. Teens will be better prepared to achieve their full potential, develop the skills they need to be competitive in the marketplace, be more successful in their future careers, live happier lives, and become productive members of their communities.

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Mobile-Based Teacher Professional Training: Influence Factor of Technology Acceptance

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Abstract. Network training provides an effective way for teachers to develop their own profession and pursue lifelong learning. With the development of mobile learning, it brings new possibilities for teacher network training. However, there is a lack of existing analysis on the influence factor of technology acceptance of mobile-based teacher professional training. The research object of this study is the teachers who participate in training based on a teacher network training platform, called Open. With reference to the existing technology acceptance model, the author constructs the technology acceptance model for mobile-based teacher professional training. A questionnaire survey was used to recover 107160 data, including 80036 valid data. Then, by using the structural equation model, the influencing factors of mobile-based teacher professional training are analyzed. With these results, the potential and inadequacies of mobile-based teacher professional training are discussed, and some suggestions are offered for teacher professional training.

Keywords: mobile learning, teacher professional training, technology acceptance model

1 Introduction

The outline of the state medium and long term education reform and development plan (2010-2020), promulgated by the Chinese government in July 2010, clearly requires to" improve teacher's professional skill, perfect training systems, develop training plans, optimize the structure of teachers, improve teachers' professional level and teaching ability." At the same time, China's 13th five-year plan (2016-2020) is proposed to insist on development of education and overall improvement of education quality. In order to improve the quality of education, we cannot do without a professional teaching staff. Teacher professional training is a systematic and targeted learning behavior, it is also a necessary way for teachers' professional development. Therefore, we must pay attention to the teacher's professional training, and take a more suitable way for teacher's professional training.

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Network training for teachers is to use the internet for learning activities. Research has shown that web-based teacher training has become the mainstream way of teacher professional development [1]. With the rapid development of mobile communication technology and equipment, the concept and method of mobile learning has also been widely welcomed, injected new vitality into network learning. The flexibility and convenience of mobile-based teacher professional training provide an effective way for teachers to get professional development.

However, there are more and more problems in the process of mobile-based teacher professional training, such as the contradiction between work and learning, lack of expert resources, difficulty in using mobile equipment and so on. A critical factor for the successful implementation of any information system is its user acceptance. The premise and basis of effective mobile learning is that users are willing to use mobile devices for learning. So, are teachers willing to adopt mobile learning for teacher professional training? From the perspective of technology acceptance, what are the factors influencing mobile-based teacher professional training? The study seeks to address the following problems to facilitate future research and development on mobile-based teacher professional training:

a) What are the elements and relations of the technology acceptance model for mobile-based teacher professional training?
b) What are the factors influencing the technology acceptance of mobile-based teacher professional training?

2 Literature review

2.1 Technology acceptance theory and model

a) Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) [2] is a well-established model that is based on the psychological interaction of a user with technology and it addresses the issue of how users accept and use information technology. TAM utilizes the constructs of Perceived Usefulness (PU), Perceived Ease of Use (PEOU) and Attitudes Towards Usage (ATU) to explain and predict technology system adoption.

b) Unified Theory of Acceptance and Use of Technology (UTAUT)

Unified Theory of Acceptance and Use of Technology (UTAUT) [3] combines elements of the theory of planned behavior and variables from previous technology acceptance models. The UTAUT posits that the use of a specific technology is directly predicted by the intention to use this technology and facilitating conditions. The intention, in turn, is directly predicted by both performance expectancy and effort expectancy toward the technology in question and by social influence. Moreover, age, gender, experience and voluntariness of use act as moderators.

Existing researches have shown that the UTAUT model has a prediction force of 70% for behavioral preferences.

2.2 Technology acceptance of mobile learning

Phuangthong and Malisawan [4] added the factor of perceived interestingness on the basis of TAM model to study the user behavior intention of mobile learning in 3G mobile Internet technology. Based on TAM model, Ma [5] adds two variables: perceived mobile value and perceived entertainment. It studies the key factors that influence mobile users' acceptance of mobile learning, and studies confirm the influence of perceived mobile value and perceived entertainment on their willingness to use. Chong et al [6] considered cultural background and other factors, and combined TAM and TPB models, concluded that factors such as perceived usefulness, perceived usability, service quality and cultural background had a significant impact on the acceptance of mobile learning in Malaysia.

Based on the model of UTAUT, Wang, Wu and Wang [7] have shown that performance expectations, expectations, social impact, perceived entertainment, self-learning management, and other factors can positively act on people's willingness to use for moving learning, where gender and age play a regulatory role. In use that UTAUT model as the theoretical foundation, Donaldson [8] research the behavioral intention of the students of the community university to move learning and the resource of mobile libraries, and studies that the performance expectation, social influence, perceptual entertainment and voluntary use are important determinants of the intention of moving learning activities, and that the two factors are not significantly affected by the effort expected and self-study management.

3 Conceptual framework and hypotheses

In order to construct the technology acceptance model for mobile-based teacher professional training, the 12 key elements of conceptual framework of this study are determined by combining the existing relevant studies, including Behavioral Intention to Use (BIU), Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Facilitating Conditions (FC), Social Influence (SI), Perceived Interactivity (PI), Learning Motivation (LM), Perceived Credibility (PC), Perceived Mobile Value (PMV), Self-management of Learning (SML), Perceived Economy (PE), and Perceived Anxiety (PA). This is shown in the table below:

Table 1. Key elements of conceptual framework.

Variable	Paraphrase	Source
Behavioral Intention to Use (BIU)	Users' willingness to use information systems	TAM
Perceived Usefulness (PU)	The degree to which a person believes that using a particular system will enhance his/her job performance	TAM
Perceived Ease of Use (PEOU)	The degree to which a person believes that using the system would be free of effort	TAM
Facilitating Conditions (FC)	The extent to which the user's existing conditions support the use of an information system	UTAUT
Social Influence (SI)	People's view of users' behavior using information systems	UTAUT
Perceived Interactivity (PI)	Users' feelings about the communication and interaction of the information system	Liu, Chen, Sun, Wible, and Kuo (2014) Joo et al (2014)
Learning Motivation (LM)	The degree to which users are motivated to learn	Wu (2011)
Perceived Credibility (PC)	The degree to which users believed that using a particular system would be free of privacy and security threats	Ong, Lai and Wang (2004) Chang, Tseng, Chou and Chen (2011)
Perceived Mobile Value (PMV)	The degree of convenience that a user feels when using a mobile information system	Huang et al (2011)
Self-management of Learning (SML)	The degree of user's planning and management of personal learning	Zhong et al (2008)
Perceived Economy (PE)	The degree to which users feel the economic cost when using an information system	Anil, Ting, Moe and Jonathan (2003) Zhang (2012)
Perceived Anxiety (PA)	The degree of how worried and anxious users are when using an information system	Celik and Yesilyurt (2013) Liaw and Huang (2015)

After determining the key elements, the study puts forward the following research hypotheses:

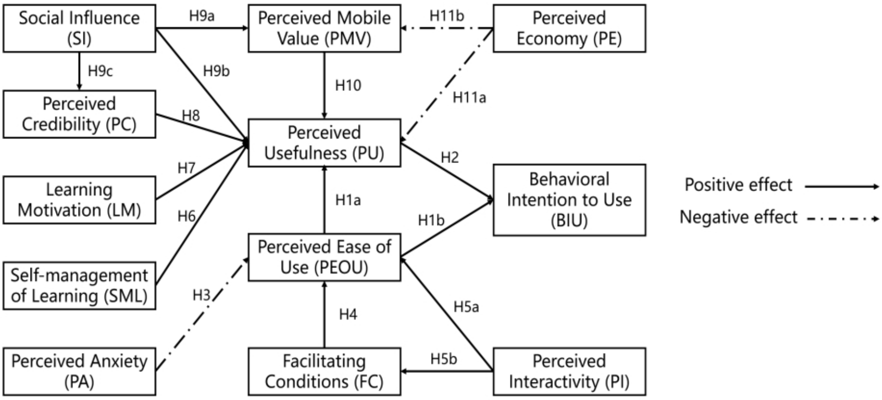

Fig. 1. Relationships between the key elements

4 Methodology

OPEN teacher network training platform is a public service system of modern distance education, which has been recognized by the ministry of education. In this study, teachers who have participated in or are participating in teacher training on the OPEN were selected as the research objects, and the teachers come from kindergartens, primary schools, middle schools, high schools or vocational education schools. In order to obtain the data of these teachers, the questionnaire was distributed by stratified random sampling, primarily in terms of teachers' areas and schools.

There were 38 questions in the questionnaire, corresponding to 12 key elements. The overall Cronbach alpha coefficient of the questionnaire was 0.959, the minimum Cronbach alpha coefficient of each elements was 0.680 and the maximum was 0.938, as shown in the following table, all above the acceptable level of 0.65 (Kaiser, 1960; Carmines and Zeller, 1979), it indicates that the reliability of the questionnaire is high. In addition, the KMO value of the scale is 0.981, and the P value of Bartlett's test is 0.000, which indicates that the variables of the scale have a strong correlation and good validity.

Table 2. Questionnaire reliability analysis results

Variable	Cronbach Alpha	Cronbach Alpha based on standardized terms	Number of questions
Total	**.959**	**.965**	**38**
Behavioral Intention to Use (BIU)	.924	.924	4
Perceived Ease of Use (PEOU)	.912	.913	3
Perceived Usefulness (PU)	.938	.938	4
Facilitating Conditions (FC)	.914	.915	4
Social Influence (SI)	.857	.863	3
Perceived Interactivity (PI)	.914	.915	4
Learning Motivation (LM)	.891	.891	4
Perceived Credibility (PC)	.879	.879	2
Perceived Mobile Value (PMV)	.840	.841	2
Self-management of Learning (SML)	.869	.869	3
Perceived Economy (PE)	.680	.680	2
Perceived Anxiety (PA)	.776	.776	3

A total of 107160 data were collected in this questionnaire, 81803 pieces of data were left after repeated questionnaires were deleted, and then remove time less than 180 seconds of filling out the questionnaire, finally got 80036 valid data. The recovery rate of the questionnaire was 74.69%.

Structural equation model (SEM) is a multivariate statistical technique, which can identify measurable variables as latent variables, so as to analyze the structural relationship between latent variables and deal with measurement errors. The AMOS software is a modeling tool for SEM, and the study used AMOS 21.0 for data analysis.

5 Data analysis and results

The structural equation model is established based on the research hypothesis, combined with the above setting of latent variables and measurement variables, the model and test results are obtained through exploratory verification.

Based on the preliminarily established model, Maximum Likelihood Estimates was used to estimate parameters. Through parameter estimation, it shows that the fitting results of the structural model are all within the acceptable range. But the path analysis results shows that the P values of the effect of Perceived Economy (PE) on Perceived Usefulness (PU) is 0.007 (<0.05), which means the relationship between the two elements is general, so the study delete this path. Then the study got a modified model, it is presented below. Each path in the modified model has a significant relationship.

Table 3. Path analysis results of the structural model

Path	Estimate	S.E.	C.R.	P	Significance
FC ← PI	0.738	0.003	215.371	***	significant
PEOU ← PI	0.219	0.004	49.586	***	significant
PMV ← SI	0.891	0.004	248.494	***	significant
PEOU ← FC	0.782	0.005	144.56	***	significant
PEOU ← PA	0.030	0.002	13.462	***	significant
PMV ← PE	-0.058	0.003	-19.832	***	significant
PC ← SI	0.862	0.004	224.774	***	significant
PU ← SI	0.084	0.009	9.699	***	significant
PU ← PMV	0.349	0.007	46.674	***	significant
PU ← LM	0.034	0.002	16.297	***	significant
PU ← PEOU	0.127	0.002	67.342	***	significant
PU ← PC	0.242	0.004	56.165	***	significant
PU ← SML	0.299	0.002	136.29	***	significant
BIU ← PEOU	0.428	0.003	163.301	***	significant
BIU ← PU	0.354	0.003	113.289	***	significant

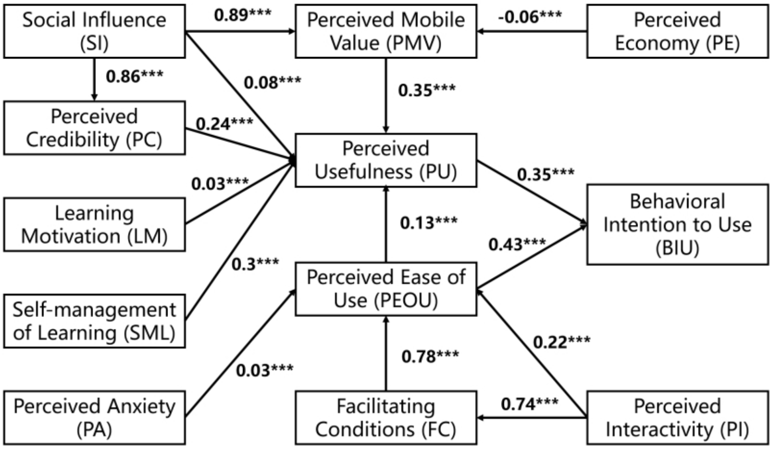

Fig. 2. Parameter estimation results of the structural model

As we can see from the table and figure above, Perceived Ease of Use (PEOU) has a greater overall effect on mobile learning intentions, followed by Perceived Usefulness (PU). The ranking of the overall effect of external variables on mobile learning intention is as follows: Social Influence (SI), Facilitating Conditions (FC), Self-management of Learning (SML), Perceived Interactivity (PI), Perceived Mobile Value (PMV), Perceived Credibility (PC), Learning Motivation (LM), Perceived Anxiety (PA), and Perceived Economy (PE). It should be noted that Perceived Economy (PE) have a negative impact on mobile learning intentions.

Through the above empirical analysis, the 16 hypothesis of research has been verified, and the verification results are shown in the following table:

Table 4. Research hypothesis verification results

No.	Research hypotheses	Result
H1a	Perceived Ease of Use (PEOU) has a positive effect on Perceived Usefulness (PU).	Accept
H1b	Perceived Ease of Use (PEOU) has a positive effect on Behavioral Intention to Use (BIU).	Accept
H2	Perceived Usefulness (PU) has a positive effect on Behavioral Intention to Use (BIU).	Accept
H3	Perceived Anxiety (PA) has a negative effect on Perceived Ease of Use (PEOU).	**Refuse**
H4	Facilitating Conditions (FC) has a positive effect on Perceived Ease of Use (PEOU).	Accept
H5a	Perceived Interactivity (PI) has a positive effect on Perceived Ease of Use (PEOU).	Accept
H5b	Perceived Interactivity (PI) has a positive effect on Facilitating Conditions (FC).	Accept
H6	Self-management of Learning (SML) has a positive effect on Perceived Usefulness (PU).	Accept
H7	Learning Motivation (LM) has a positive effect on Perceived Usefulness (PU).	Accept
H8	Perceived Credibility (PC) has a positive effect on Perceived Usefulness (PU).	Accept
H9a	Social Influence (SI) has a positive effect on Perceived Mobile Value (PMV).	Accept
H9b	Social Influence (SI) has a positive effect on Perceived Usefulness (PU).	Accept
H9c	Social Influence (SI) has a positive effect on Perceived Credibility (PC).	Accept
H10	Perceived Mobile Value (PMV) has a positive effect on Perceived Usefulness (PU).	Accept
H11a	Perceived Economy (PE) has a negative effect on Perceived Usefulness (PU).	**Refuse**
H11b	Perceived Economy (PE) has a negative effect on Perceived Mobile Value (PMV).	Accept

A total of 16 hypotheses were proposed. Among them, the research hypothesis H11a that Perceived Economy (PE) has a negative effect on Perceived Usefulness (PU) has not passed the test, so as to H3 that Perceived Anxiety (PA) has a negative effect on Perceived Ease of Use (PEOU), and the other research hypotheses are valid.

The key factors influencing mobile-based teacher professional training including Social Influence (SI), Perceived Mobile Value (PMV), Facilitating Conditions (FC), Self-management of Learning (SML), Perceived Credibility (PC), Perceived Interactivity (PI), Perceived Economy (PE), Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). The Perceived Economy (PE) has a negative effect on Perceived Mobile Value (PMV), which in turn affect Perceived Usefulness (PU), and affect the Behavioral Intention to Use (BIU). The resulting model is as follows:

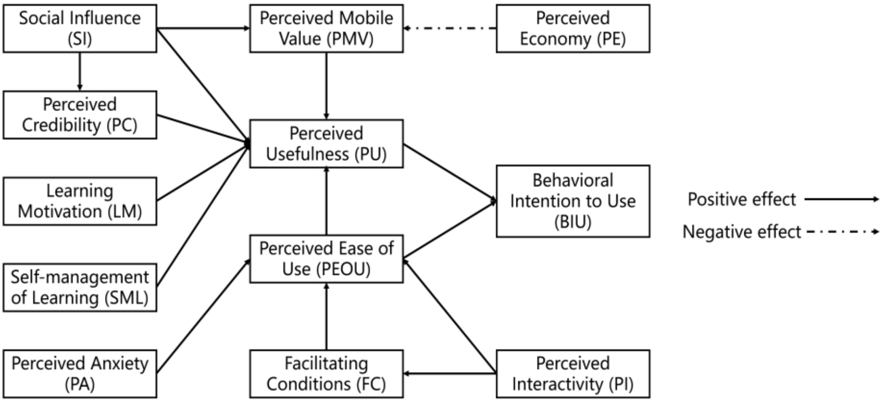

Fig. 3. The resulting model

6 Discussions and conclusions

The same as the research hypothesis, Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Facilitating Conditions (FC), Social Influence (SI), Perceived Mobile Value (PMV), Learning Motivation (LM), Perceived Credibility (PC), Perceived Interactivity (PI), and Self-management of Learning (SML) have a significant positive effect on Behavioral Intention to Use (BIU). While Perceived Economy (PE) has a significant negative effect on Behavioral Intention to Use (BIU).When teachers feel mobile-based teacher professional training is useful and easy to use, they are more likely to choose this way. When teachers feel mobile-based teacher professional training is convenient, they also feel it is easy to use. When people around the teacher are trying mobile-based teacher professional training, they feel it more useful and credible. If teachers feel the advantages of mobile technology, they also feel it is useful. Teachers who have a higher enthusiasm in professional training are more willing to try mobile-based teacher professional training. When teachers think mobile-based teacher professional training is credible, they also feel it is useful. When teachers think mobile-based teacher professional training has a good interactive experience, they also feel it is easy to use. Teachers with stronger self-management ability in learning usually achieve better results in their professional training, and also feel it is useful. The economy conditions is usually a barrier for teachers to choose more advanced methods of teacher professional training. If mobile-based teacher professional training costs too much, teachers will be less willing to use it.

Different from the research hypothesis, Perceived Anxiety (PA) has a positive effect on Behavioral Intention to Use (BIU). And Perceived Economy (PE) has nothing to do with Perceived Usefulness (PU). With the wide popularity of mobile technology and mobile learning, teachers do not feeling much anxious about mobile-based teacher professional training. And it reflects that teachers are more rational, they believe that there is no significant association between price and value.

In general, from the perspective of technology acceptance, we came to three conclusions:

a) The two key factors influencing mobile-based teacher professional training is Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). And Perceived Ease of Use (PEOU) has a significant positive effect on Perceived Usefulness (PU).
b) Social Influence (SI), Perceived Mobile Value (PMV), Self-management of Learning (SML), Perceived Credibility (PC) and Learning Motivation (LM) have a significant positive effect on Perceived Usefulness (PU). And Social Influence (SI) has a significant positive effect on Perceived Mobile Value (PMV) and Perceived Credibility (PC). While Perceived Economy (PE) has a negative effect on Perceived Mobile Value (PMV), and has nothing to do with Perceived Usefulness (PU).
c) Facilitating Conditions (FC), Perceived Anxiety (PA) and Perceived Interactivity (PI) have a significant positive effect on Perceived Ease of Use (PEOU). And Perceived Interactivity (PI) has a significant positive effect on Facilitating Conditions (FC).

For the further study, researchers need to know more about what teachers think about mobile-based teacher professional training, such as using interviews to explore the deeper influencing factors, and continue to pay attention to this group.

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Personalized Adaptive Learning: An Emerging Pedagogical Approach Enabled by a Smart Learning Environment

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Abstract. Smart devices and intelligent technologies are enabling a smart learning environment to effectively promote the development of personalized learning and adaptive learning, in line with the trend of accelerating the integration of both. In this regard, we introduce a new teaching method enabled by a smart learning environment, which is a form of personalized adaptive learning. In order to clearly explain this approach, we have analyzed its two pillars: personalized learning and adaptive learning. From this analysis, we have also explored the core elements of personalized adaptive learning and its core concepts. On this basis, we further construct a framework of personalized adaptive learning. We hope this paper will provide readers with a clear understanding of personalized adaptive learning, and serve as an endeavor to contribute to future studies and practices.

Keywords: smart learning environment • data decision-making • personalized learning • adaptive learning • man-machine collaboration

1 Introduction

With the development of technology, technology-enhanced learning has gradually entered classrooms and experienced four changes [1]: a) e-learning, b) m-learning, c) u-learning, and d) s-learning (Smart Leaning). Against such background, the technology-enhanced learning environment has also evolved from the e-learning environment to smart learning environment (SLE). As a high-end form of e-learning [2], SLE has features of tracking learning process, recognizing learning scenario, awareness of physical environment, connecting learning communities, easy, engaged and effective learning. [3], which bring learners more flexibility, effectiveness, adaptation, engagement, motivation and feedback [4]. Therefore, SLE should be able to promote the development of personalized learning and adaptive learning effectively.

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In fact, personalized learning and adaptive learning have always been the core goals of a SLE. Huang [3] defines SLE as a learning place or activity venue for promoting effective learning. Kinshuk mentioned that personalized learning and adaptive learning are two kinds of this effective learning that SLE mainly focuses on in an interview [5]. The development of current technologies has made personalized learning increasingly adaptive, adaptive learning increasingly personalized. Such a trend is much more obvious in smart technology-enabled SLE. A revised teaching method, personalized adaptive learning, will come along with this trend. The new personalized learning approach is automated and uses decisions based on data gathered by an automated system; it accommodates learning to learners' real-time learning conditions, and makes the learning content and activities meet learners' individual characteristics and needs. In this paper, we aim to explore the core concepts of a new form of personalized learning and construct an appropriate framework in order to provide a reference for scholars to carry out follow-up research and for educators to explore practical ways to implement personalized and adaptive learning in the age of automated learning support systems.

2 Analysis: Comparing the two pillars of personalized adaptive learning

2.1 The differences and similarities between personalized learning and adaptive learning

Personalized adaptive learning is formed by the combination of personalized learning and adaptive learning. A variety of past definitions are shown in Table1. The left side is a list of definitions of personalized learning. Three common core elements are highlighted, namely *individual differences*, *personal needs* and *personal development* (a.k.a individual vision). The right side is a list of definitions of adaptive learning. Three elements, *individual differences*, *individual performanc*e and *adaptive adjustment* can be extracted from these definitions. In that sense, this revised form of personalized adaptive learning in not new. Rather, it builds of prior attempts to make learning more individually meaningful.

Table 1. Comparison between Personalized Learning and Adaptive Learning

Personalized learning	Adaptive learning
Personalized learning refers to instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner. Learning objectives, instructional	Adaptive learning refers to the technologies monitoring student progress, using data to modify instruction at any time. [7]

approaches, and instructional content (and its sequencing) may all vary based on learner needs. In addition, learning activities are meaningful and relevant to learners, driven by their interests, and often self-initiated. [6]	
The pedagogy of personalising learning is learner-centred. It is an inclusive process which challenges those involved to meet the needs of all learners, particularly those learners who are vulnerable or hard to reach. [8]	Adaptive learning technologies dynamically adjust to the level or type of course content based on an individual's abilities or skill attainment, in ways that accelerate a learner's performance with both automated and instructor interventions [9]
Personalized learning refers to a learning paradigm that aims at promoting students' individual development, emphasizing that the learning process should adopt appropriate teaching methods, techniques, content, starting points, processes, and evaluation methods to meet the individual characteristics and development potential of students, so that all aspects of students could be developed fully, freely and harmoniously [10]	Adaptive learning strategies create a student experience that is modified based on a student's performance and engagement with the course materials. At its heart is an approach to instruction that relies on technology and data about student performance to adjust and respond with content and methodologies that develop a pathway to the student's mastery of a particular learning objective. [11]
Core Elements: individual differences, personal needs, personal development (vision)	**Core Elements:** individual differences, individual performance, adaptive adjustment

Intuitively, both personalized learning and adaptive learning focus on individual differences which, mainly individual characteristics, is the purpose of differentiated instruction. Therefore, both contain *differentiated instruction*, which in the past has been reserved for special needs students. Furtherly, the individual differences in personalized learning includes two parts: individual characteristics and non-individual characteristics. The latter is actually one aspect of personal needs and personal development. According to the definition of personal needs, the gap between the current situation and the intended state of a learner, the difference of students needs is determined by the current state and the intended state. The former can be part of individual characteristics, and the latter can be attributed to personal development. In this way, the core elements of personalized learning can be refined into two aspects: *individual characteristics* and *personal development*. One new aspect of personalized adaptive learning is the recognition of individual learner interests and desires as relevant to education.

The above definitions of adaptive learning do not show it emphasize the personal development of students. Therefore, the individual differences in adaptive learning are mainly related to the differences of individual characteristics. Thus, the core elements of adaptive learning can be modified into *individual characteristics*, *individual performance* and *adaptive adjustment*. Comparing the new core elements of both learning methods, personalized learning does not mention the implementation strategies, but adaptive learning does (adaptive adjustment). A second new aspect of personalized adaptive learning is an emphasis on designs and implementations that in fact support individual development.

2.2 Constructing the relational diagram among related learning methods

It can be concluded from the above, there is no limit to the number of students for personalized learning, adaptive learning, and differentiated instruction. Therefore, they are not individualized instruction. However, the most dependent on high-end technology of adaptive learning, it is more concerned with the specific situation of each individual than the other two methods. In addition, from the perspective of personality, differentiated instruction, focusing on the difference of individual characteristics, has the lowest personalized level; adaptive learning comes second, it rises to the level of individual performance; personalized learning is the highest, reaching the pursuit of personal development. These are visually depicted in Fig.1.

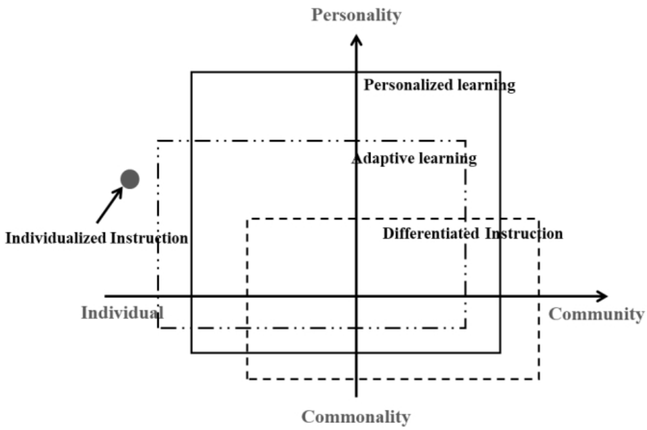

Fig. 1. Relationships among Related Learning Methods

3 Core concepts: The values of Personalized Adaptive Learning

Combining the core elements of personalized learning and adaptive learning, the core elements of personalized adaptive learning can also be proposed: *individual characteristics*, *individual performance*, *personal development*, and *adaptive adjustment.* The first three represent three personalized levels of personalized adaptive learning. The fourth indicates that adaptive adjustments strategy of teaching to achieve these three personalized levels. Like adaptive learning, this strategy is inseparable from the empowerment of technology. Based on these four elements, personalized adaptive learning can be defined as a technology-empowered effective pedagogy which can adaptively adjust teaching strategies timely based on real-time monitored (enabled by smart technology) learners' differences and changes in individual characteristics, individual performance, and personal development.

The assumption behind this core concept is the same as that of adaptive learning, namely, the appropriate is the best. Because each individual is different in all aspects and is in a state of constant change, it is necessary to personally monitor them in real time and adjust the teaching in an adaptive manner to ensure that the teaching strategy is always suitable for the individual student. In addition, this concept, like smart education, needs to adhere to the view that "technology promotes education rather than leads education" [12]. This is because, so far, few technologies were created for teaching, and the convenience pursued by technology is not what education seeks [13] which is the effectiveness of promoting human development.

4 Framework: The Portrait of Personalized Adaptive Learning

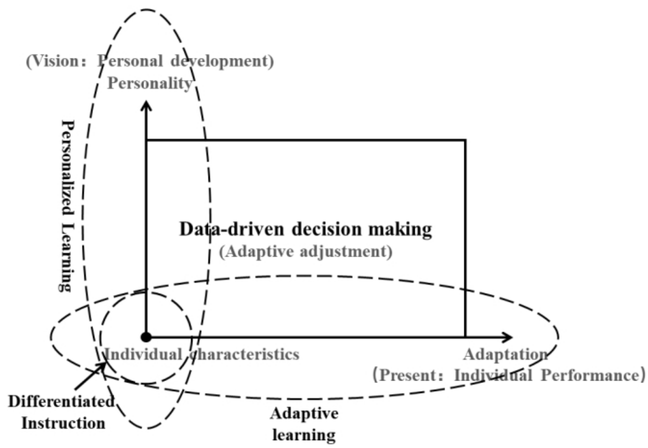

Fig. 2. Personalized Adaptive Learning Framework

Based on the above core elements and core concepts, a framework of personalized adaptive learning is constructed. As shown in Fig. 2, the horizontal axis acts as an adaptation axis to characterize the current individual performance and the vertical axis is used as a personality axis to characterize the personal development. The two-axis intersection acts as individual characteristics to represent differentiated instruction shared by personalized learning and adaptive learning.

Fig. 2 indicates three ways to achieve personalized adaptive learning: 1) Adjust the teaching strategies based on the differences in individual characteristics (circular); 2) on this basis, adjust the teaching strategies combined with the differences and changes in current individual performance (horizontal ellipse); 3) on the basis of 1), adjust the teaching strategies combined with the differences and changed in personal development vision (vertical ellipse). All of three approaches can be implemented by adaptively adjusting teaching based on data-driven decision-making. Therefore, the framework depicted in Fig. 2 takes data-driven decision-making as the core hub.

Acknowledgements

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Prototyping theory: Applying Design Thinking to adapt a framework for Smart Learning Environments inside organizations

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Abstract. This paper inquires into how an empirical smart learning environment (SLE) framework is applied inside an established corporation. The authors investigate how an SLE framework needs to be embedded into a corporate environment to encourage employees to innovate sustained SLEs. This paper is based on the assumption that interaction and co-creation foster employees' capabilities to adapt a theoretical framework to their workplace. While such frameworks are indeed made applicable for practitioners, the application itself is rarely properly investigated. The authors argue for the need to discover and emphasize the tactics, strategies, and practices to adapt frameworks into practice. Therefore, the paper introduces a five-day design sprint concept based on design thinking principles. It discusses employees' application of the SLE framework, reveals current obstacles, and highlights the unexploited potential to create human-centered, strategically implemented, and innovative smart learning use cases.

Keywords: smart learning environments, human-centered design, interdisciplinarity, design sprint, new work, design thinking

1 Introduction and Problem Statement

Koper [1], Hwang [2], and others [3, 4] define smart learning environments (SLEs) as a future vision of learning. Technology-enhanced learning approaches like pervasive, adaptive, ubiquitous, or combinations of these in SLEs are mostly unknown in educational settings. Only a very few pilot projects have been developed and applied in practice. An area-wide transfer of SLEs into practice is not recognizable, although education has become even more important in the age of digitalization. Currently, new approaches, like an SLE framework [5] or design thinking (DT), have emerged to enhance lifelong learning inside organizations [6]. The socio-technical SLE framework [5] aims to translate theoretical findings into practice by developing smart learning prototypes out of a holistic design process. While the latest research often only focuses on theoretical findings, employees and managers struggle to transfer and adjust the provided scientific results to their specific challenges [7] due to the regulations, organizational barriers, or design narratives included in the theoretical work. However, without adaptions, the

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scientific findings cannot be exploited to their full potential in order to develop innovative, future-oriented capacities to solve complex challenges. The authors argue for the need to apply this SLE framework [5] to an interactive learning journey, like a design sprint, to enhance employees' ownership to facilitate its adaptation to processes and results in organizational contexts. They aim to identify success criteria in order to transfer a theoretical framework into practice by discussing two leading questions: (1) How do we appropriately transfer a theoretical framework into an established corporation? (2) Which principles and characteristics enable practitioners to adapt an existing framework to their work context?

2 Design Thinking as a Human-Centered Design Approach

Since its emergence in the 1980s, DT has become tremendously popular. The term originally gained traction in design research to explain designers' practices [7]. Beginning in the early 2000s, a growing number of talks and publications popularized DT outside the realm of design proper, particularly in progressive business environments. In fact, DT has become something of a catchphrase in the context of innovation and (digital) transformation. Beyond talk, however, many organizations began to embrace principles and aspects of DT in their work routines. The authors understand DT to be a human-centered design approach that is, according to Buchanan [8], a set of principles based on human rights and human dignity, including iteration, collaboration, hands-on prototyping, testing, and emphasizing the user and his or her context.

2.1 A Design Sprint as an interactive learning format

An interactive learning journey is inspired by the concept of a design sprint, which describes a product development method that is well suited for innovating digital products [9]. The format serves to map out an efficient, iterative design process, often also labeled as "DT" in practice. Basically, a design sprint encompasses DT principles and combines them with agile software development methods that are divided into five phases: *Understand*, *Diverge*, *Converge*, *Prototype*, and *Test.* A customized smart learning *design sprint kit* contains all the exercises needed for a workshop to guide, facilitate, and document each phase of product development, making the whole process more effective.

3 Applying Design Thinking to Transfer Smart Learning Concepts into Practice

One of the authors conceptualized and moderated the learning journey based on design thinking principles. From April until June 2018, she facilitated two SLE design sprints in one major multinational engineering and electronics company in Berlin, Germany. Each interactive workshop, based on a *bottom-up* and iterative approach, lasted for 3–4 days and featured 5–8 participants from departments such as human resources, marketing, information technology (IT), technical communication, training, user experience, and business model innovation. She documented all the activities via pictures, videos, working templates, and reflection notes accompanied by feedback loops with the participants. Both of the authors have collaboratively evaluated all documents by using a grounded approach.

3.1 Smart learning Design Sprint

In the first two days, the participants became familiar with the SLE approach and framework (Fig. 1, no. 1, 2) and defined their challenges and learning visions via reflecting on their current organizational situation (Fig. 1, no. 3). The third day focused on smart learning ideation by, for example, providing the participants with experiments on virtual reality (VR) and augmented reality (AR) learning solutions (Fig. 1, no. 4) and adapting the SLE framework to fit within their organizational processes (Fig. 1, no. 5). Overall, the SLE framework serves as an iterative planning, analysis, and development approach combining socio-technical dimensions of influence. The framework contains 30 success factors assigned to five design patterns representing a holistic SLE. The success factors are categorized into the following spheres of influence: corporate culture, user centricity, didactical variety, learning space, and technical learning assistance [5]. To adapt these to the ideated learning solutions, the employees used a canvas for each design pattern with specific questions regarding the transfer into their working environment (Fig. 1, no. 5). The participants followed a structured and iterative approach consisting of ideation and adaption. The last day bundled the previous results into exercises in smart learning rapid prototyping (Fig. 1, no. 6). One of the authors used various digital and physical exercises with tangible and multimedia materials. The innovated smart learning prototypes were used to gather feedback within a subsequent user research investigation project (completed on 10/10/2018) and to iteratively refine the first prototypes in order to develop SLE minimal valuable products (MVPs).

4 Identified Success Criteria to Adapt a Framework for SLEs Inside Organizations

The authors' findings are particularly focused on principles that enable employees' capability to adapt the framework to a situated context. First, investigating their needs and fears demonstrated that a set of tools that they choose themselves leverages their engagement. Choosing their *best fit tool* allowed the participants to integrate their preferences, to combine digital and non-digital tools, and to design their individual learning journeys. Second, the results revealed that a periodic change of working mode, such as listening, using all five senses, analyzing, ideating (cf. Fig. 1), and changing from divergent to convergent phases enhanced participants' concentration and involvement. Third, a three- to five-day learning journey fostered a group flow feeling that allowed them to fully immerse themselves in the challenge.

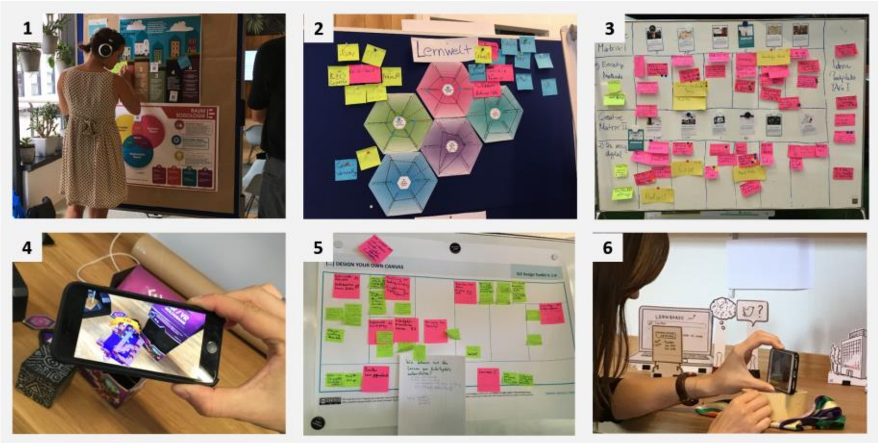

Fig. 1. Impressions from different phases of the design sprint (designed by the authors).

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Research on the Status Quo of Smart School Development in China

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Abstract. Smart school is the development frontier of ICT in education. Understanding the status quo of smart school development has a positive impact on promoting the construction and development of smart school. This study surveyed and analyzed the development of 34 smart schools in China from the five dimensions of ICT infrastructure, digital resources, ICT application, information literacy and safeguard mechanism. The results indicated that the development of the schools across five dimensions is not balanced, the smart schools showed no difference between urban schools and rural schools, while the difference of safeguard mechanism between primary school and secondary school existed. Based on the findings, this study suggested that the development of safeguard mechanism and ICT infrastructure should be improved, and secondary schools could employ more ICT staff and improve school staff training quality.

Keywords: Smart school · ICT development · Informatization evaluation

1 Introduction

In 2008, IBM first proposed the concept of "smarter planet", which has led people to pay attention to smart school. And many researches have been done on smart school [1]. However, the development of smart school in China has just started [2]. In order to promote the development of smart school in China, there are many problems to be solved. While the researches in China are mainly about the concept and architecture of smart school [3]. Understanding the current status of smart school construction can help take measures against specific problems so as to promote the further development of smart school. Therefore, this study systematically investigated the development status of smart primary and secondary schools in China from five dimensions – ICT infrastructure, digital resources, ICT application, information literacy and guarantee mechanism, which are extracted from related literature and

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policy documents based on the bibliometric method and have combined the opinions based on Delphi method. This study may provide some reference for related research.

2 Literature

The research on smart schools is becoming more and more important, and more and more scholars begin their exploration [4]. International research on the smart school focus on the system development, such as energy management system [5], people flow and environmental monitoring platform [6], disaster management system [7]. Chinese scholars focuses on concept discussion and overall framework design of smart school [8], which is a preliminary exploration of the smart school from a broad perspective. Besides, the system development of smart school in China is still in the initial stage. And only a few scholars studied the status of the smart school. Lee, Jo, Li and Rha investigated the perceived ability of college students about ICT application [9], which only focus on students' information literacy in the smart school. Gao and Nie conducted research on the current status of the smart school from four dimensions - infrastructure, smart management, smart teaching and learning, and development of teachers and students [10], which ignored the dimensions of resources, school administrators development, technical staff development and safeguard mechanism. Li investigated the current situation of the smart school in vocational colleges in Jiangsu province mainly from five dimensions - the teachers and students development, ICT application, digital resources, infrastructure, and organizational safeguard mechanism [11], which ignored the dimensions of development of school administrators and technical staff. Different research on current status of smart school focus on different dimensions, and most of them tend to ignore other roles besides teachers and students in smart school.

As mentioned above, the development of smart school in China has just started. Researchers mainly explored the concept and overall framework design of smart school. There only a few researches on the current status of smart school. Existing relevant research investigated the status of smart school from different dimensions like ICT infrastructure, resources, ICT application, teacher and student development, safeguard mechanism. These studies lack a comprehensive survey of smart school. Therefore, it is necessary to systematically and comprehensively investigating the current situation of smart school development in primary and secondary schools, which could promote the overall development of smart school in China.

3 Method

The study developed a questionnaire and surveyed 34 primary and secondary schools in China. In order to understand the status of these smart schools' development, the entropy method and the weighted average method were used to calculate the evaluating value, which stood for the development of the smart school. After normality test and homogeneity test of variance, the study used *t*-test to analyze the difference in these schools.

3.1 Research Sample

34 primary and secondary schools were selected by convenience sampling, which located in Hubei province in China. The sample included 19 primary schools and 15 secondary schools. Regionally, there are 25 urban schools and nine rural schools.

3.2 Questionnaire Design

Based on the bibliometric method, the study preliminary extracted five dimensions about smart school construction in China from existing research and policy documents, and designed the preliminary questionnaire based on previous researches [12-16]. According to the Delphi Method, experts in the field of smart campus, informatization management department and leaders of excellent schools were invited to review the preliminary questionnaire and the final questionnaire was got based on their opinions. The questionnaire contains five dimensions, including 64 items in total consist of true or false items and Likert-scale items - ICT infrastructure (16 items), digital resources (10 items), ICT application (17 items), information literacy (8 items), and safeguard mechanism (13 items). The overall Cronbach's alpha of the questionnaire is 0.94, and the Cronbach's alpha values of the six factors are 0.72, 0.73, 0.93, 0.98, and 0.79. All the Cronbach's alpha values greater than 0.70 indicate that the reliability of the questionnaire is good.

4 Result

4.1 The Status Quo of Smart School Development

The evaluating results demonstrate that the development of the smart schools in the five dimensions is not balanced, as shown in Fig. 1. The evaluating value of information literacy is maximum and far higher than others, while the evaluating values in the dimension of safeguard mechanism and ICT infrastructure are lower than that in other dimensions.

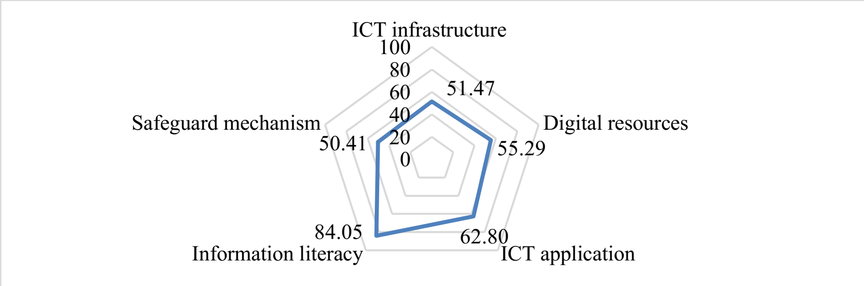

Fig. 1. The evaluating values across 5 dimensions

4.2 Smart School Development in Different Regions

The five dimensions of these schools are consistent with the normal distribution, and there is no significant difference between urban and rural schools' variances, indicating that the sample is suitable for *t*-test. The study used *t*-test to confirm the difference of smart school development between urban schools and rural schools. As shown in Table 1, the results indicated there is no significant difference between urban schools and rural schools among the five dimensions.

Table 1. Descriptive data and *t*-test result of the smart school development in different regions.

Dependent variable	School regions	*N*	Mean	SD	*t*	*p*
ICT infrastructure	Urban school	25	52.72	22.29	0.53	0.60
	Rural school	9	47.99	25.20		
Digital resources	Urban school	25	56.81	23.68	0.56	0.58
	Rural school	9	51.06	33.78		
ICT application	Urban school	25	60.63	22.89	-0.88	0.38
	Rural school	9	68.84	26.70		
Information literacy	Urban school	25	85.78	14.45	0.97	0.34
	Rural school	9	79.24	24.23		
Safeguard mechanism	Urban school	25	52.09	19.91	0.81	0.43
	Rural school	9	45.74	21.24		

4.3 Smart School Development across Different School Types

Similarly, there is no significant difference in the variance between primary and secondary schools. In order to investigate the differences of smart school development across different school types, this study used *t*-test to confirm the difference of smart school development between primary school and secondary school. Only in the dimension of safeguard mechanism, it showed significant difference between primary school and secondary school ($t = 2.51$, $p < 0.05$). And the safeguard mechanism development of primary school (M = 57.57) is better than that of secondary school (M = 41.35).

Furthermore, for the in-depth study of the source of safeguard mechanism differences, this study used *t*-test to analyze the difference of the 13 items in the dimension of safeguard mechanism, which found only four items (ICT staff, teachers' ICT competency training, administrators' ICT related training and ICT staff training) were significant different between primary school and secondary school. All the four items values of primary school were greater than those of secondary school. The results indicated that, in order to narrow the gap with primary schools, secondary schools need improve the development of ICT staff, teachers' ICT competency training, administrators' ICT related training and ICT staff training.

5 Discussion and Conclusion

This study investigated the development status of smart school in central China. The results show that the development of these schools across five dimensions is not balanced. Specifically, the development of safeguard mechanism and ICT infrastructure leaves much to be improved. Considering the findings of previous studies [17] and our research findings, safeguard mechanism and ICT infrastructure are the key factors in the development of smart school in the current stage in China. In order to promote the development of smart school, school administrators could pay more attention on safeguard mechanism and ICT infrastructure, such as providing more ICT equipment. Furthermore, this study found that urban schools and rural schools showed no significant difference in five dimensions, while the difference of safeguard mechanism between primary school and secondary school existed. According to the further findings, this study suggested that secondary schools could increase manpower input in ICT and improve school staff training quality.

Smart school is an important part of ICT in education in China [18]. In order to understand the development of smart school, taking primary and secondary schools in central China as an example, this study explored the development of these smart schools, analyzed their differences between regions and school types, and put forward some suggestions. The findings of this study might provide reference and support to the healthy and efficient development of smart school.

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Towards the Enactment of Learning Situations Connecting Formal and Non-Formal Learning in SLEs

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Abstract. Smart Learning Environments hold promise of adapting learning processes to the individual context of students and connecting formal with non-formal learning. To do so, SLEs need to know the current context of the students, regardless of the physical or virtual space where learning takes place. This paper presents an architecture that assists in the deployment and enactment of learning situations across-spaces, able to sense and react to changes in the students' context in order to adapt the learning process.

Keywords: smart learning environments, context, formal and non-formal learning, reaction, enactment

1 Introduction

Smart Learning Environments (SLEs) are Technology-Enhanced Learning (TEL) environments able to adapt the students' learning experience and to provide them with personalized support at the right time and place, considering their individual needs and context [1]. SLEs can support across spaces learning situations (i.e. situations spanning multiple virtual and physical spaces [2]) and involving different technological elements such as Virtual Learning Environments (VLEs), mobile and wearable devices or Internet of Things (IoT) devices. All these components of SLEs provide data about students' actions and progress, which can be used for making adaptation decisions at enactment time.

The inherent support of SLEs to adaptable across-spaces learning provides interesting opportunities for connecting formal and non-formal learning [3]. To do so, SLEs need to evaluate the context of each student, comprising what happens in multiple spaces (*e.g.* posts, reads, quizzes, etc. in the VLE; or movements, actions and interactions with others sensed by IoT in the physical space), detect opportunities to enrich the learning process in non-formal contexts by proposing additional resources and activities that connect to what is formally designed to be

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learned, and finally intervene at the right time and place suggesting these extra learning resources.

To the best of our knowledge, previous works in the literature have not addressed the problem of combining the support to formal and non-formal learning happening across-spaces within the context of SLEs. This paper proposes an SLE architecture that deals with this open issue.

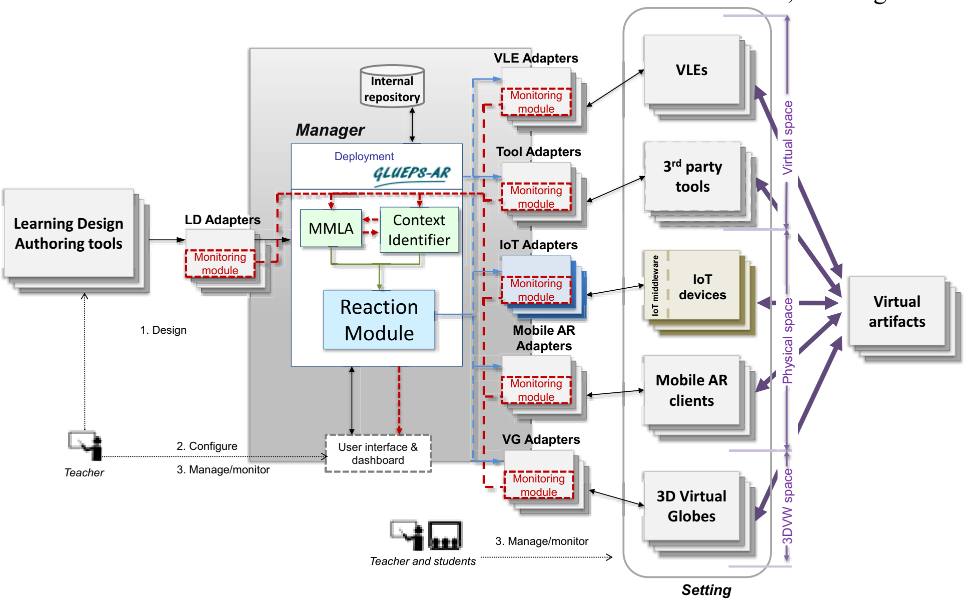
2 Architecture Proposal

SLEs can be characterized by the following actions at enactment time: (1) **sense** the students' actions and their current context, (2) **analyze** the gathered data to identify their individual context and (3) **react** accordingly and offer the adapted learning resources and activities. All these actions may happen in any of the different learning spaces in which students formally participate, but also outside them, extending the support to non-formal settings. Nevertheless, to the best of our knowledge, the SLEs proposals in the literature focus on only one of these spaces.

The interest in connecting different learning spaces is not a novelty within the TEL community. Notably, GLUEPS-AR [4] is a system that can take a formalized learning design and set up the tools, resources and groups of students to carry it out across multiple spaces, including VLEs, 3D Virtual Globes and Augmented Reality browsers, allowing students to access the same artifacts in all of them, thanks to an adaptor-based architecture that favors software reuse and third-party tool integration (*e.g.* Google Docs, YouTube, Twitter, etc.). Nevertheless, GLUEPS-AR cannot be considered a SLE since it cannot sense students' actions, analyze the context or intervene during run time. Besides, it provides no connection between formal and non-formal learning since all learning activities need to be designed by the teacher a priori.

This paper proposes the addition of modules to GLUEPS-AR to enable these features, as shown in Figure 1. More specifically, new modules include: (1) the inclusion of IoT devices, which enhance the interactions with the physical space; (2) the Context Identifier and MultiModal Learning Analytics (MMLA) modules, that benefit from the diversity of complementary data sources from different learning spaces for a better understanding of both students' individual contexts and the learning processes [5]; and (3) the Reaction Module, which determines the appropriate way to assist each student based on the results of the previous modules.

With the new additions, the system will be able to assist students across-spaces while connecting formal and non-formal learning. Once the instructor has produced a learning situation, enriched with metadata about its educational context, the system configures and deploys the required resources thanks to the adaptors to the spaces in which students are expected to participate. At enactment time, the monitoring modules present in these adaptors sense students' interactions with resources existing in these spaces and send the data to both the Context Identifier and MMLA modules. The results of these modules are then used by the Reaction Module to take decisions to intervene in the students' current context, once again



via the adaptors without the intervention of teachers.

Fig. 1. Architecture proposal, based on GLUEPS-ER [4]. The original architecture is depicted in grey, while new modules are highlighted with different colors.

3 Example of a Learning Situation

For the sake of illustration, a learning scenario supported by the system is presented. During a Natural Science course, the instructor has designed a learning situation aimed at helping students differentiate the trees in the school yard. This situation is composed by three activities: (1) a preliminary quiz, (2) a gymkhana within the school yard where students have to find specific trees in groups and (3) a final report. The system deploys this situation and configures the required resources through the adapters: the quiz and the submit area for the report are created in the VLE, while the IoT beacons placed in the school yard and configured to represent each of the goals in the gymkhana. Furthermore, an application is installed in participants' cellphones to enable the system gathering information like location or level of noise.

As the learning situation progresses, the system gathers data about how students perform in the activities and reacts according to the students' current context. Adaptations can occur in the formal learning (*e.g.* the analysis module finds that a group is struggling in the gymkhana, as they visit random trees without clear intention, and the Reaction Module decides to change their next goal of offer them some clue). But interventions also address the potential of non-formal learning, for example if the context module detects (through the student cellphone) that she is walking through a park. In that case, the reaction module can suggest some extra resource (*e.g.* a web page with information on the trees of the park) or activity (*e.g.* a trivia game with questions about trees) that reinforce her learning towards the goals of the formal learning design.

4 Conclusions and Future Work

SLEs can potentially enhance students' learning connecting formal and non-formal learning, but they need relevant resources for both contexts. The architecture proposed addresses this issue, reacting to students' actions across-spaces. Future pilot scenarios will evaluate the system's interventions and users' impressions.

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Using augmented reality in a beginning drawing course for design students

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Abstract. Augmented reality was used to enhance learning in a drawing studio course. Examination of the use of augmented reality centered on representational drawings of interior architectural spaces. Aspects of perspective and examples of previous work were presented in the environment, allowing students to see how a space could successfully be rendered by hand. Specific instructions for the construction of perspective drawings were also developed. Results from the course will be presented. The authors wished to know whether or not the use of augmented reality increased the beginning design students' ability – or stereognostic sense – in translating three-dimensional space into two-dimensional drawings.

Keywords: augmented reality • drawing • studio • design

1 Introduction

Augmented reality (AR) and virtual reality (VR) are two of the latest technological tools used to entertain and educate. Important distinctions between the two are the level of immersion as well as the hardware and software necessary to create the different experiences. Both technologies have received considerable media attention over the past few years.

Augmented reality offers a significant advantage over virtual reality – AR does not require any hardware aside from a smart device. Currently, most college students have smart phones [1]. A 2018 report by the Pew Research Center states that 94% of all adults aged 18-29 own a smartphone [2]. VR on the other hand, requires expensive hardware, such as the Oculus Rift or HTC Vive headsets or specs. And while Google has developed an affordable cardboard headset, the need for additional equipment to utilize the technology limits its use.

A growing number of augmented reality applications and software are being developed to educate. Anecdotal examples include how AR is better preparing surgeons for the operating room and how teachers are using AR to help students explore the far reaches of the world without leaving the classroom.

A specific academic use of augmented reality was an interface developed to replace costly mechanical parts, such as common bearings and gears, with projections of different views of these objects. This was done in an effort to reduce "the time, effort and monetary cost needed for developing various educational

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materials for teaching hand-drawn mechanical drawing" [3]. An additional objective of the study was the students' development of manual drawing acuity and a stereognostic sense of the objects drawn. Another recent example, an enhanced version of AR – or spatial augmented reality (SAR) – sought "to improve speed or ease [of] drawing by projecting photos, virtual construction lines and interactive 3D scenes" [4]. The latter differed from the former in that the AR component was projected in the physical space rather than viewed through the screen of a smart device.

Such experiences are adding an additional, invaluable layer to education at every level, especially as educators attempt to accommodate the different learning styles of their students. This paper concentrates specifically on a basic AR application in a beginning drawing course for students studying graphic design and interior design.

2 Augmented reality and beginning drawing

Augmented reality was used to help teach a studio drawing class. The course, titled Drawing in Two- and Three- Dimensions, is a required, first-year drawing course for students in apparel, graphic and interior design in the Department of Design, Housing and Apparel at the University of Minnesota. The goal of the course is to develop drawing skills for representation and design thinking. We have found the use of augmented reality can benefit drawing instruction in design-related courses.

In our graphic design program, students are required to take only one drawing course as part of their degree requirements. Therefore, the course must serve as a solid basis of drawing throughout their four-year program. On average there are 20 students enrolled in each section of the course and most are majoring in graphic, apparel or interior design.

The overall skill set of each class varies greatly. A surprising number of students in the course have little or no previous drawing experience. For those who struggle with drawing, augmented reality can provide a means to elevate their skills in a relatively short period of time. It can also enhance the skills of advanced students by helping them reach new levels. Lastly, AR can level the playing field because technology makes it possible to concentrate on the resulting idea rather than the visual acuity and manual dexterity necessary to execute the drawing.

A long-standing and rigorous assignment for the course is to create a drawing of an interior space of the building where the course is taught. Completion of the drawing is also a requirement for a subsequent mandatory portfolio review for all students. The finished drawing must show a significant expanse of three-dimensional space and be rendered by pencil on paper. The drawings must be full value, with a value range from black to white.

Students construct the linear perspective drawings while sitting throughout the spaces. While photographs are often used to record the space and light at a given time, development of drawing skill in the physical environment is the primary objective.

Prior to beginning the drawing, examples of previous student work has been presented in the studio on a projection screen. However, augmented reality allows the presentation of drawings *in situ*, at the location from where it was created. This use of technology allows the students to examine how a given location has been well illustrated in the past.

Fig. 1: Image located in building environment

A free augmented reality service offered by Zapworks was used to overlay digital images of previous student drawings onto the actual space represented in the drawings. In effect, it is an exhibition of pencil drawings that allows students to see how their peers have approached the design problem in the past by using AR. See Figure 1.

mcneal_hall_0007.
Sit in the middle of the atrium by the column closest to the main building entrance on the ground floor looking toward the wide staircase to the first floor.

Fig. 2: Typical identification code [currently active]

To view the work, students needed to download the free app associated with the smart device's operating system from the respective app stores. Students then scanned the identification codes (similar to QR codes) posted in the different areas of the building that connect to the online drawings of the interior space.

3 Drawing construction

One aspect of learning to draw an interior space is the construction of correct perspective. In a subsequent use of augmented reality, the images were expanded to include identification of structural components necessary for a successful one-, two- or three-point perspective rendering including horizon lines, vanishing points, converging lines, station points, ground line, ground plane, picture plane, and center line of vision [5]. Additional techniques used in representational drawing were identified in the AR enhancements, such as when to use sighting techniques and angle gauges vs. linear perspective. This allowed students to see how drawings can be constructed by hand to create a realistic representation of space.

In order to better present the idea of how space looks when enhanced with construction lines, various locations within the building were equipped via augmented reality codes, or markers.

4 Exhibition

Finally, at the completion of the term, students in the class were able to "mount" an exhibition of their work while maintaining the safety of their rendered drawings and without printing large exhibition quality copies of the work. Student work was tagged and illustrated throughout the spaces of the building for all of the community to view in augmented reality.

Results of the course will be compared with previous versions in terms of student acceptance, quality of the work, and long-term impacts of the learning process. Additional ways of applying augmented reality to the design curriculum will also be explored.

5 Citations

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