Simon K.S. Cheung · Lam-for Kwok
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Blended Learning

Aligning Theory with Practices

9th International Conference, ICBL 2016
Beijing, China, July 19–21, 2016
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Preface

Welcome to the 9th International Conference on Blended Learning (ICBL 2016), which was formerly known as International Conference on Hybrid Learning (ICHL). This year, ICBL 2016 was held at Peking University, Beijing, China, during July 19–21, 2016.

Undoubtedly, blended learning or hybrid learning has become one of the promising approaches to teaching and learning. It aims to integrate traditional learning with innovative means, such as e-learning and open online learning, in order to create a new learning environment to enhance learning effectiveness and enrich learning experience. Hybrid learning literally refers to the combination of traditional learning and nontraditional learning. Blended learning emphasizes not only the combination but also the integration of various modes of learning. This aligns with the latest practices in the field, and hence, our conference name changed accordingly.

ICBL 2016 provided a platform for knowledge exchange and experience sharing among the researchers and practitioners in all areas of blended learning. The theme of ICBL 2016 was "Blended Learning: Aligning Theory with Practices." The focus was placed on how the theoretical ideas and concepts of blended learning can be adopted as good education practices to enhance learning effectiveness and enrich learning experience. The conference was included keynote addresses and parallel paper presentations.

This year, we received over 60 paper submissions. After a rigorous review process, 34 papers were selected for inclusion in this volume. The selected papers cover various areas in blended learning, including collaborative and interactive learning, open and flexible learning, content development, assessment and evaluation, pedagogical and psychological issues, and experience, strategies, and solutions of blended learning.

We would like to take this opportunity to thank the following parties who made the conference a success: (a) the conference Organizing Committee; (b) the international Program Committee; (c) the organizers and co-organizers; (d) the sponsors; (e) the publisher of the conference proceedings; and (f) all the conference participants.

We trust you will enjoy reading these papers.

July 2016

Simon K.S. Cheung
Lam-for Kwok
Junjie Shang
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Beijing Normal University, China
Professor Li Chen is a PhD supervisor. She is a Vice President of Beijing Normal University and the Executive Director of Beijing Institute for the Learning City at Beijing Normal University. She is the President of the Society of International Chinese in Educational Technology, and the President of China Association for ICT in Education for K12. Professor Chen is the leader of Master's and PhD programs on Distance Education at Beijing Normal University. Her research is mainly focusing on interaction principle in distance education and the policy research in lifelong learning. She has authored and published more than 10 books and 100 papers. Professor Chen is deeply engaged in policy consulting in distance education and lifelong learning.

Owen P. Hall Jr.
Pepperdine University, USA
Professor Hall received his PhD from the University of Southern California. He holds the Julian Virtue Professorship and has more than 35 years of academic and industry experience in computer decision systems and technological forecasting. He authored numerous technical papers and several books on computer-based management decision systems. The founder of a high-technology sensor company, Professor Hall has also served on several government panels and corporate boards. Honoured as a Harriet and Charles Luckman Distinguished Teaching Fellow, he has been involved in developing the Graziadio School's entrepreneurial and e-learning programs. His current area of research includes the application of artificial intelligent tutors and integrated blended learning to management education. Professor Hall is a registered professional engineer, State of California and is a member of the Beta Gamma Sigma Honour Society. He is the former Editor-in-Chief of the Graziadio Business Report. He was honoured with the Howard A. White and Sloan Teaching Excellence Awards.

Horace H.S. Ip
City University of Hong Kong, China
Professor Ip is the Vice-President in Student Affairs and a Chair Professor of Computer Science at City University of Hong Kong. He has a BSc in Applied Physics and PhD in Image Processing from University College, London, United Kingdom. His research interests include multimedia content analysis and retrieval, and virtual reality for education. Professor Ip's research has won many awards including Prix Ars Electronica, and a Gold Medal of the Geneva Salon International Des Inventions. He has published over 300 papers in international journals and conference proceedings. Professor Ip is a Fellow of the Hong Kong Institution of Engineers, a Fellow of the Institution of Engineering and Technology, a Fellow of the British Computer Society and a Fellow of the International Association for Pattern Recognition.

Zhuzhu Wang

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While leading the National Center for Educational Technology and the National Resource Center for Basic Education for the Ministry of Education (MoE), Professor Zhuzhu Wang is also an Adjunct Professor of East China Normal University and Peking University. Her research interests fall in areas of ICT in basic education and distance education in China. Professor Wang has led many national and MoE key projects, organized or participated in the planning and implementation of national major projects in distance education and ICT in education. She published numerous research papers and the book *Theory and Practice of Project Management in Distance Education*, introducing project management theories in distance education in China.

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Professor Harrison Yang received his Doctor of Education from Florida International University. In addition to his appointment at State University of New York at Oswego (SUNY Oswego), he is the Dean of the School of Educational Information Technology at Central China Normal University. Professor Yang's research specialties include assessment and e-folios, distance/flexible education, information literacy, information technology diffusion/integration, learning theories, issues and trends on vocational-technical education, and Web/learning communities. Professor Yang is the recipient of the SUNY Oswego President Award of Teaching Excellence (2006).

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Investigating Collaborative Learning Effect in Blended Learning Environment by Utilizing Moodle and WeChat

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Abstract. With recent development of collaborative studies in blended learning, the importance of exploring its effect has been widely acknowledged. Combining multiple technologies in support of collaboration is challenging. In order to facilitate the fruitful execution of the collaborative learning techniques, the study explored the pedagogical effectiveness in blended learning environment combining Moodle and WeChat simultaneously. A total of 78 students participated in this experiment as part of a half-semester information technology education course, the course contained an online forum supporting the students' collaborative discussion after class, adopting social network analysis (SNA), content analysis and questionnaires to analyze social network structure feature, collaborative knowledge building level and learning effects in Moodle and WeChat. Experimental results suggest that Moodle is superior to WeChat. Moodle can promote effective collaborative learning and a majority of students prefer to collaborate in Moodle. The discovery presented in this paper can be helpful for future researches on blended collaborative learning settings.

Keywords: Collaborative learning · Moodle · WeChat · Blended learning environment

1 Introduction

With the increasing amount of available information in the Internet, collaboration learning emerged to be a hot spot for intelligent knowledge management. The growth in use of technology to support collaborative learning in higher education has attracted a rapidly growing number of research studies focused on some aspect of technology-supported collaborative learning [1]. Large numbers of researchers explored the collaborative activities and its effectiveness learning using a variety of technological means. The amount of carrying out collaborative learning in online forum increased per day. Recently, collaboration learning has attracted more and more researchers' interest. Collaboration learning consists of two or more students laboring together and sharing the workload equitably as they progress toward intended learning outcomes [2]. Students can benefits of this pedagogical approach include: (a) students' mutual assistance and support, (b) the exchange of information and resources, (c) sharing of opinions and points of view, (d) enhanced critical thinking through

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material discussion, and (e) development of the necessary skills for effective teamwork [3]. Students in collaborative learning environments must articulate their own points of view and also listen to the views of others to create knowledge and meaning together [4]. When learners share the same goal in a collaboration situation, they can learn from one another through group discussion. Puntambekar indicated that the main point of collaborative learning is the interaction between individual and team members because it allows knowledge sharing through different points of view [5].

A large number of studies have recognized the crucial role of Computer-supported collaborative learning (CSCL) in making learning more effective [6]. Learning Management Systems (LMS) offer affordances beyond simple document repositories, by featuring discussion forums, online chat rooms, grade books and the ability to give automatically marked tests such as multiple choice questionnaires [7]. Moodle is one of the most popular contemporary open source web-based LMSs, it provides a friendly environment for collaborative learning.

On the other hand, the wide spread of mobile devices and wireless technologies brings an enormous potential to e-learning, in terms of ubiquity, pervasiveness and personalization etc. Mobile collaborative learning (MCSCL) is considered the next step of online collaborative learning by incorporating mobility as a key and breakthrough requirement [8]. As a representative of the mobile social application, WeChat gradually attracted researches' attention. WeChat publish information and establish mini learning circles through public number, as well as its convenient and efficient means of communication, WeChat can be effectively achieved collaborative learning and created a flexible learning environment.

Current trends show that we need to utilize a variety of technology means to facilitate collaborative learning [1]. In order to create more powerful collaborative learning environment, enrich technological means, we combine Moodle and WeChat these two types of technology environment for its representation and availability, which allows teachers to explore exciting novel opportunities for collaborative learning on the hybrid environment. Thus, this paper focus on accessing effects of collaborative interaction and knowledge building level by utilizing Moodle and WeChat. On the basis of the results of this study, the implications for improving the effectiveness of collaborative learning will be explored in the conclusion.

2 Related Work

In this section, we present related work, which focus on the LMS: Moodle and mobile environment: WeChat. Through this study, it should become apparent how we can amplify the strengths of each educational approach by fruitfully combining them. This study research on exploring the effect of using Moodle and WeChat can be justified.

2.1 LMS: Moodle

So far, Moodle has been used for higher education. Its strengths are the realization of communication tools, and the creation and administration of learning objects [9]. Teachers utilize Moodle to build up course, create discussion forums, chats, resources and workshop. The system has been designed to support modern pedagogies based on social constructionism and focuses on providing an environment to support collaboration, connected knowing and a meaningful exchange of ideas [10].

Previous research shows that Moodle may be an effective technique to support collaborative learning. Wang studied high school physics courses collaborative learning in Moodle, cultivate students' creative ability and sense of collaboration, achieve the integration of technology and curriculum [11]. Other researchers analyzed the elements of online collaborative learning, combined with Moodle for teaching apply and created novel model of collaborative learning, the result shows that Moodle provides a friendly environment for collaboration [12].

However, continuous enhancements in computer technology and the current widespread computer literacy among the public have resulted in a new generation of students that expect increasingly more from their e-learning experiences [13]. In order to keep up with such expectations, we should change from exploit single technology to multi-technologies and enrich collaborative learning settings.

2.2 Mobile Environment: WeChat

Mobile devices have become increasingly popular, and many mobile applications have been developed to reshape teaching and learning strategies [14]. So far, WeChat has become the fastest growing mobile application and internet services [15]. As a smart mobile terminal social application, WeChat supports chat for free, send pictures, videos, and text through multiple mobile devices. WeChat has a development of low cost, a convenient registration, spreading fragmented knowledge, and devices, and it can also complement each other between the online teaching platform and mobile learning platform [16].

Collaborative learning is becoming more popular, increasing research shows the effectiveness of using WeChat as collaborative learning environments. Wu inquired collaborative learning mode under the support of WeChat, the results shows that the collaborative learning supported WeChat can enhance the learning interest effectively and promote students learning [17]. According to literature investigation, relatively little researchers explored the effect of collaborative learning using WeChat.

Hence, this study attempts to utilize a variety of methods, such as social network analysis, qualitative analysis, questionnaire and content analysis to explore social network structure feature and collaborative knowledge building level in blend learning environment. Combining these two types of learning platforms may allow teachers to explore exciting new opportunities for collaborative learning on the Moodle and WeChat multiple technology environments.

3 Research Method

3.1 Participants

The participants of the experiment were third-year university students in a CE (Computer Education) department who learned an information technology education course (total participants = 78, of whom 52 males; mean age, 21 years; age range, 20–24 years).

3.2 Experiment Design

The Questionnaire Design. A questionnaire survey was administrated to all the 78 students before the start of the course and after course. Pre-test aimed at knowing the basic circumstance about students who utilize Moodle and WeChat. The pre-test result indicated that every student installed WeChat application software in mobile phone, and most of them were familiar with Moodle. So they can easily apply two means of information technology to collaborative learning. Post-test questionnaires to measure students' collaborative learning effect in blended learning environment.

Collaborative Learning Task Subjects. In this study, we use 6–8 students as collaborative group size. Applying student-centered group discussions in online forums (Moodle and WeChat) to support students' collaborative learning. Designing task-driven collaborative learning model. In task 1, the collaborative learning topic was hot spots in educational technology fields. Tasks 2 and 3 were information technology knowledge in junior middle school.

Organization and Implementation of Collaborative Learning Tasks. Our study was conducted during the spring of 2015 in the context of a 16-week (from March to June) course taught by teacher to 78 students. At first teacher gave an introduction intended to help students learn to basic collaborative knowledge. Then arrange three collaborative tasks after class. The task was organized into several phases, each of which lasted 1–2 weeks. Phase 1 was draft works submission in Moodle, phase 2 was group collaborative review in two platforms, phase 3 was final works submission and discussion in Moodle (see in Fig. 1).

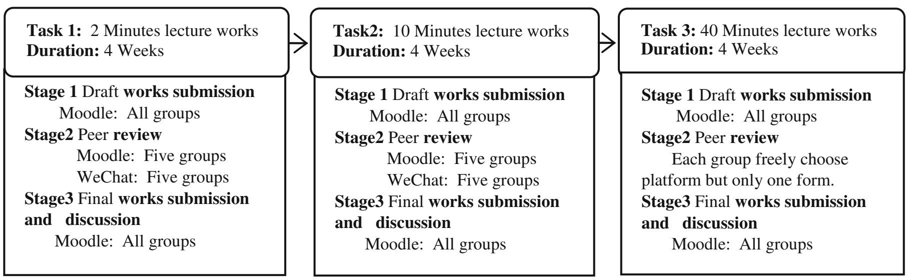

Fig. 1. Organization form in collaborative tasks

3.3 Data Analysis

Social Network Analysis. Social network analysis is focused on uncovering the patterns of relations between individuals in social networks [18]. SNA provides a useful technique to study the social construction of knowledge [19]. Centrality degree is a measure of someone's power or influence within a network, the higher the degree of centrality, the greater the proportion of nodes adjacent to the node in question, and the more access that node has to information and social capital [20]. In this study, centrality degree was used to analysis the students' interactive activity for the whole network and for each participant.

Our SNA based on forum discussions collated at the end of the course revealed a network with 78 nodes. The interactive data were collected in Moodle system logs and chat screen in WeChat reserved by student in the course of collaborative activities, a complete comment was marked an interaction. At first we should change the interactive data of each group in each task into an N * N symmetric relation matrix, matrix "0" indicates no relationship between the two actors, and "1" indicates that existing a relationship between the two actors, matrix values represents the strength of the relationship, nodes in rows and columns represents a student. Ruling the matrix "rows" are the information senders and "columns" are the information receivers [21]. Then import the interactive matrix data into the UCINET software for data analysis (see Table 1).

Table 1. The Group interaction matrix

The group interaction matrix						
	1	2	3	4	5	6
1	–	0	1	0	1	1
2	1	–	0	1	1	1
3	1	1	–	0	1	1
4	1	0	1	–	0	1
5	1	1	0	1	–	1
6	0	3	1	1	1	–

Content Analysis. Online discussion is transparent and all discussion posts can be retrieved easily from the online computer system. Researchers suggested that with a different research purpose or a different theoretical framework, a novel research project generally requires new coding themes for analysis [22]. Content analysis of participants' text-based transcripts is an effective technique for researchers to get a better understanding of participants' cognitive processes and of the quality of online learning [23, 24].

Therefore, focusing on examining the evidence of knowledge building in online forums from a constructivism paradigm. In this study, we developed the online learning knowledge building model, drawing on the Gunawardena's concepts on the interaction analysis model (IAM) for students, and then integrated relative topics from course which we studied. This analysis scheme retains shallow collaboration, middle collaboration, and deep collaboration (See Table 2). After reaching 100 % agreement on scoring two sample weeks' transcripts, both raters double-blindly scored the rest of the transcripts. The inter-rater reliability is 0.85. The two raters also discussed the differences in their codes and reached an agreement at 100 %. The final revised codes were used for analyses.

Table 2. Encoding table for the online learning knowledge building model

Category	Subclasses	Description
Shallow collaboration	Short response S1	Simple words in reply, for example, "Got it" "Agreed"
	Shallow evaluation S3	Giving their personal reasons when commenting, or simply describing personal behavior or ideas
Middle collaboration	Content evaluation M1	Asking and answering each other and comparing the differences
	Content recommendations M2	Using experience and literature to analyze and summarize, give personal opinions or suggestions
Deep collaboration	Profound thoughts D2	Reflecting deeply on the passages in comments, Thinking in depth and sharing unique personal insights or ideas

4 Result

4.1 Collaborative Knowledge Building Level Analysis

- In Moodle, the proportion of Moodle occupied the highest proportion in middle collaboration followed by shallow collaboration, deep collaboration. Most of students may achieve the middle collaborative level (Fig. 2).
- In WeChat, the proportion of WeChat occupied the highest proportion in shallow collaboration followed by middle collaboration, deep collaboration. Most of students may achieve the shallow collaborative level.

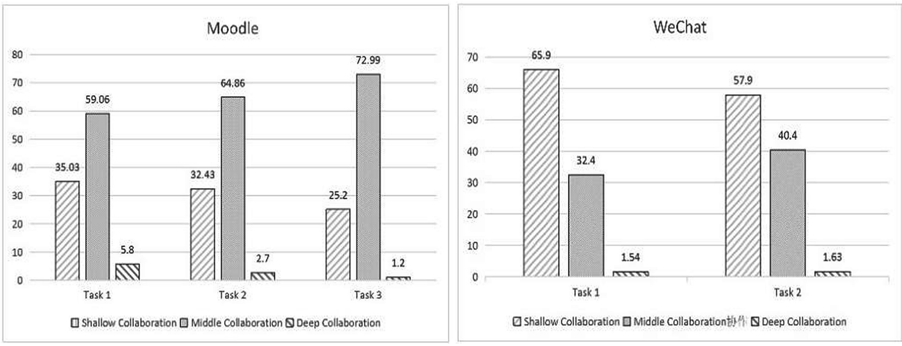

Fig. 2. Collaborative learning level in Moodle and WeChat

4.2 Social Network Structure Analysis

The socio-grams in Moodle and WeChat were drawn using UCINET6.0 (Figs. 3–5). The actors located in the core, periphery and isolated positions may be determined by analyzing the centrality degree.

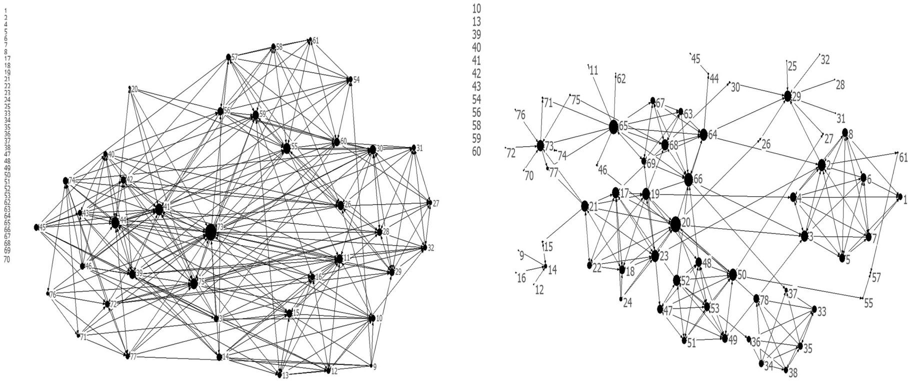

Fig. 3. Task 1 Network structures in Moodle (left) and WeChat (right)

- The interaction within group (nodes 54 to 61, nodes 39 to 46, etc.) and interaction among groups in Moodle are intensive. The interaction within group (nodes 17 to 23, nodes 64 to 69, etc.) is higher than those among groups in WeChat. The overall network structure in Moodle shows closely, but relatively loose in WeChat.
- The number of peripheral nodes in Moodle is less than WeChat. Such as nodes 11, 62 and 45 (each node centrality is 1), which indicates that these nodes only have an interactive behavior.
- There are several isolated nodes in two platforms. For example, nodes 1, 2 and 5 in Moodle and nodes 10, 13 and 39 in WeChat, which indicates that these nodes has never participated in class interaction (each node centrality is 0).
- The WeChat socio-gram is more intense than task 1 and begin to appear core nodes apparently (nodes 3, 35, etc.) (Fig. 4).
- Nodes 3, 35, 73 and 44 shows the highest degree of centrality (the centrality is 28, 30, 29 and 30 respective). Which indicates that these nodes are the most active in online interaction.
- The interaction in all groups are more active and closely linked, the core nodes increase and fully share the information and resources.

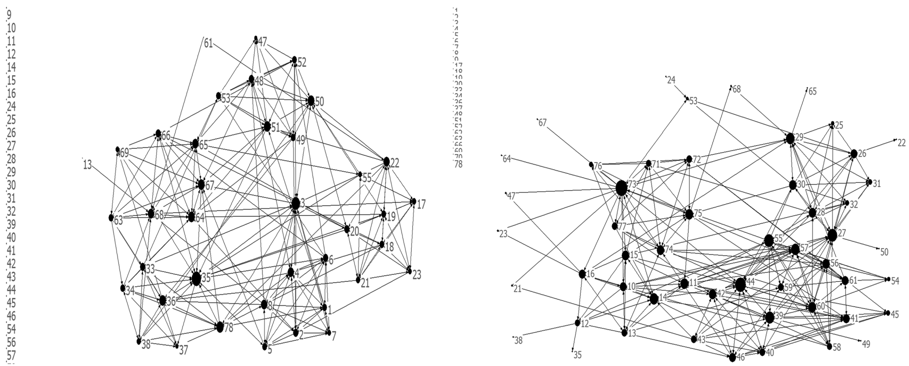

Fig. 4. Task 2 Network structures in Moodle (left) and WeChat (right)

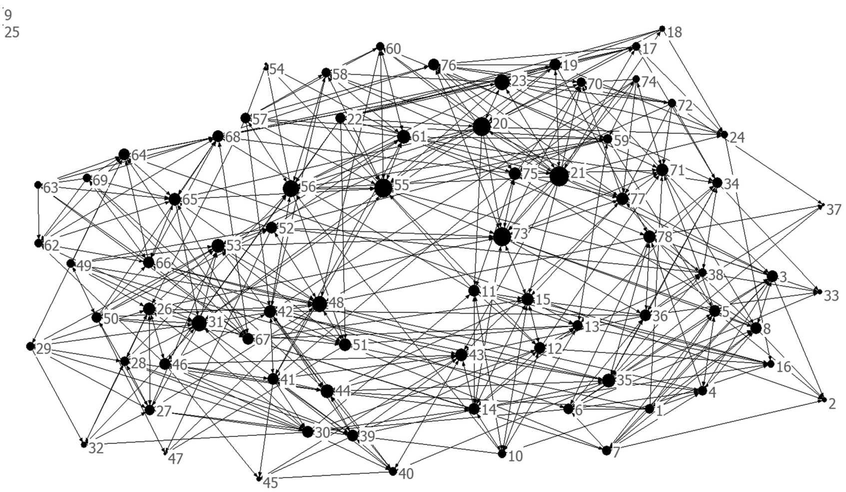

Fig. 5. Task 3 Network structure in Moodle

- In task 3, almost all groups choose the Moodle for collaborative discussion, relatively little students choose the WeChat.

4.3 Post-test Questionnaire

After completed all the teaching projects, we carried out post-test questionnaire for comparing the collaborative learning effect in blended learning environment. The questionnaire was filled in a website, used Likert 5 points, score 1 means strongly disagree and 5 means strongly agree. 78 questionnaires were returned. The number in table represents the percentage of each question.

Table 3. Usefulness for Collaborative learning in Moodle and WeChat

Questions	5	4	3	2	1
Moodle is useful for students to collaborate learning	41.9	55.4	2.7	0	0
WeChat is useful for students to collaborate learning	17.6	48.6	24.3	8.1	1.35
Moodle is useful for students to collaborate learning on individual and group knowledge summary	51.4	43.2	5.4	0	0
WeChat is useful for students to collaborate learning on individual and group knowledge summary	13.5	45.9	24.3	12.1	1.3
Moodle is useful for students to collaborate learning on sharing individual knowledge and ideas	51.4	47.2	1.3	0	0
WeChat is useful for students to collaborate learning on sharing individual knowledge and ideas	28.3	47.3	14.9	8.1	0

As we can see in Table 3, Most students think (strongly agree and agree) Moodle is useful for collaborative learning.

From Table 4, The WeChat has a lower proportion than Moodle in operation, expression of personal views and collaborative discussion. Moodle operating environment is more suitable for collaborative learning.

From Table 5, the results indicates that students can better utilize Moodle for collaborative learning, there are also has a large part of students prefer to utilize Moodle in terms of willingness to use.

Table 4. Operation and Usability in Moodle and WeChat

Questions	5	4	3	2	1
Operating Moodle is more convenient (viewing the teacher lectures, browse resources, etc.)	60.8	36.5	1.3	1.3	0
Operating WeChat is more convenient (viewing the teacher lectures, browse resources, etc.)	14.9	32.4	35.1	12.1	5.4
Moodle is convenient to express personal views	51.4	43.2	5.4	0	0
WeChat is convenient to express personal views	27	43.2	14.9	14.6	0
The collaborative discussion in Moodle is easy to use	48.6	39.2	10.8	0	0
The collaborative discussion in WeChat is easy to use	22.9	37.8	20.3	14.9	2.7

Table 5. Satisfaction and Willingness to utilize in Moodle and WeChat

Questions	5	4	3	2	1
I am satisfied with the material presented in Moodle platform	62.2	35.1	2.7	0	0
I am satisfied with the material presented in WeChat platform	8.1	40.5	33.8	13.5	4
Collaborative learning effect in Moodle is satisfied	59.5	39.2	1.3	0	0
Collaborative learning effect in WeChat is satisfied	9.5	48.6	25.7	14.9	1.3
The Collaborative learning function presented in Moodle is satisfied	59.5	36.5	4	0	0
The Collaborative learning function presented in WeChat is satisfied	14.9	39.2	31.8	14.9	0
I would like to continue to utilize Moodle in future course	62.2	33.8	4	0	0
I would like to continue to utilize WeChat in future course	20.3	35.1	31.1	10.8	2.7

5 Conclusions and Discussion

This paper based on Moodle and WeChat blended learning environment, combining the quantitative analysis and qualitative analysis methods, including social network analysis and content analysis to analyze social network structure feature and collaborative knowledge building level in Moodle and WeChat platforms, accessing effects of collaborative learning in this blended learning environment. The conclusions are as follows:

- Students using Moodle for collaborative review have a higher quality than WeChat, students can achieve middle collaborative building level, however shallow in WeChat, the community collaborative knowledge building level in online environment superior to mobile environment, but less in deep level. Most of students evaluate peers' assignment in shallow or give personal opinion, less heated debate and deep discussions to problem from multiple perspectives. Group member's conflicts affecting the interaction and debates integration behavior in knowledge building process, affecting the overall knowledge building process.
- Compared to the WeChat, Moodle is more conducive to strengthening collaborative learning and interaction, the collaborative communication channel is richer. Online learning platform Moodle fully embodies the advantages of collaborative learning and interaction.
- In Moodle and WeChat, there are some core people act as a key role in connecting collaborative group and interactive cliques, which plays an essential role in the supervision and guidance. They raised a lot of questions and ideas for partner's assignments among the group and group of others, which paid more attention to members, affecting the interaction in entire network structure. There are also have some inactive students, they rarely interacted with other members though had once interactive behavior, which enthusiasm is not strong. Probably they have never review peer's assignments initiatively or theirs own assignments are not attract the other members.
- Compared to the WeChat, Moodle has a better effect on collaborative learning. Online collaborative learning has changed the traditional way of learning, crossed the limitations of time and space. The survey results indicate that students think Moodle is suitable for collaborative learning, which has a high level of usefulness, satisfaction and willingness to use. Future instructional design can be considered combining different types of learning platform and achieving a great collaborative learning effect.

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Writing Collaboratively Via WIKI: An English Teaching Study

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Abstract. Based on the theories of collaborative learning, process-oriented writing, formative assessment and peer assessment, this study presents the author's empirical research on applying Wiki to teaching English writing. It further discusses the way of using Wiki to assist teaching English writing, and under its assistance, how learners' writing can be improved, and thus from what aspects it takes effect. The results turn out that writing on Wiki does take some effects in improving the efficiency of teaching English writing and enhancing learners' writing proficiency. With this empirical research, the authors hope this study provide useful implications for the relevant educators and teaching researchers to find out a new mode for teaching collaborative English writing.

Keywords: Wiki · Collaboration · Process-oriented writing · Peer assessment

1 Introduction

China's English Curriculum Reform in basic education brings forward that the overall objective is to develop students' comprehensive language skills. Writing, as one of the four basic language skills, plays a significant role in English teaching. However, the traditional method of teaching writing, the product-oriented method, only focuses on the accuracy of the final product and ignores the writing process which the students go through to reach the final goal [1].

While at the same time, autonomous learning has become an increasingly important concept in foreign language education [2]. Chinese New Curriculum also advocates enhancing students' autonomous learning ability [3]. For most teachers, one of the problems they are facing nowadays is how to provide a learning environment outside the classroom where students can learn autonomously at their own paces whenever and wherever they like to evaluate their own learning. What's more, they also need a space where students can learn collaboratively, allowing them the opportunity to communicate. Therefore, in the field of language learning, people not only pay attention to autonomous and self-directed learning, but also provide opportunities for learners to interact with each other [4]. With the development of social media, web tools like BBS, weblog and wiki are introduced into writing teaching. In the light of these applications, how to apply social networking into the teaching of English writing, by focusing on the

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students' writing process, giving them the opportunity to collaborate with each other, thus to improve their English writing skills, is a challenging but meaningful issue for all the educators and teaching researchers.

As a kind of collaborative writing system, Wiki catches more and more attention of language teachers and provides direct enlightenment for the writing teaching innovation [5]. Theoretically, wiki meets both the requirement of process-oriented writing and collaborative learning. However, empirical studies on collaborative and processed-oriented writing are still rare. Therefore, we need to carry out a study of Wiki's application and practice in the teaching of English collaborative writing to see its outcomes, methods and limitations.

2 Related Works

2.1 On Wiki's Application in Education

A wiki is a website which allows collaborative modification of its content and structure directly from the web browser [6]. As for its openness, simplicity and collaborative feature, wiki attracts quite a great application in education.

The application of wiki in education abroad can be summarized as follows: information sources, student assignment hand-in collaborative web-writing, problem solving, project spaces, anchored collaboration, focused discussions, case libraries, cross class/courses projects, for community building among students, for learning to collaborate, and so on [7]. For instance, the Uniwakka developed by CALPER has been well employed in the teaching of writing in Chinese, German, Russian, Spanish, Korean, and Arabic, as well as in the classes where English is used as the second language [8].

In China, the application of Wiki is mainly conducted in colleges or universities [9]. To sum up, the application includes: sharing resources, writing on-line dissertation, applying Wiki in teaching writing, providing teachers' teaching design platform, developing web-based curriculum, processing modification for treasury papers, functioning as knowledge base and others like education encyclopedia, providing environment for teachers and students to exchange online learning, collaborating to create, and solving problems, etc.

2.2 On Collaborative Writing

Collaborative writing becomes a popular research topic since the 1980s when researchers began to study its process [10]. Murray once questioned the notion that learning to write must necessarily be an isolated individual process, and he proposed an alternative strategy in which learners are required to collaborate in order to complete the writing task successfully [11]. Actually, in our daily life, most writing taken place is interactive or collaborative, such as project work, posters, etc. According to Wang [1], writing can be both collaborative and solitary.

Rachel Rimmershaw effectively generated the definition of collaborative writing as "any piece of writing, published or unpublished, ascribed or anonymous, to which more than one person has contributed, whether or not they grasped a pen, tapped a keyboard, or shuffled a mouse" [12].

Collaborative writing accommodates the principles of social constructivism as proposed by Vygotsky. And according to Nagelhout, collaborative writing arouses learners' awareness of writing as a process, and focuses on each of the phase of the writing process. Semones described the collaborative writing as a process built on action-reaction responses. He explained to us how the collaborative writing process works: in this communicative process, unskilled writers can learn from others to write, and skilled writers can benefit from exchanging ideas and comments to perfect their works [13].

Empirical studies on collaborative writing have found that collaborative wring can help learners to get several viewpoints and different expertise, to reduce errors and to obtain a better, more accurate text [10]. Experiments also suggest that collaborative writing can be possible to make knowledge explicit and to construct the collective memory of the learners [14].

Since collaborative learning mirrors the social nature of language and writing, applying collaboration to writing may be of great influence on improving learners' writing skills. In order to have a clearer understanding on how collaboration takes effect on writing process, we also need to check out some theories on the process-oriented writing.

2.3 On Process-Oriented Writing

As one of the four basic language skills, writing is often regarded as a means to consolidate language that is recently studied. In recent years, both teachers and students donate importance to develop writing skills. Nevertheless, attention, for most of the time, is just paid to the final product of students' writing task. The traditional product-oriented method of teaching writing may be fruitless because it pays great attention to the accuracy of the final product but ignores the process, during which students go through to reach the final goal. The process approach to writing in which writing activities serve to encourage a process of brainstorming, drafting, writing, feedback, revising and editing, is therefore recommended by many educators.

The process-writing mode was proposed by Graves in 1978, which advocated that teachers should help students to understand and assimilate the whole writing process. It is theoretically based on the process teaching theory and the communicative theory, regarding writing process as the communicative activity of a group [15].

According to Brown [16], the process approach to writing focuses on the process that leads to the final written product; helps student writers understand their own composing process; helps them build repertoires of strategies for prewriting, drafting, and rewriting; gives students time to write and rewrite; places central importance on the process of revision; lets students discover what they want to say as they write; gives students feedback throughout the composing process (not just on the final product) to consider as they attempt to bring their expression closer and closer to intention; it encourages feedback from both the instructor and peers; and it includes individual conferences between teachers and students during the process of composition. Many empirical studies have been carried out on process-oriented writing, and most of which follow the mode as prewriting, first draft, revising/editing/teacher or peer conferencing, and final product.

3 The Study

This study focuses on the application of Wiki in teaching collaborative English writing. With the purpose of finding out whether Wiki can assist teaching English writing effectively, based on the theories of collaborative learning and process-oriented writing, the research questions are confined to the following aspects:

(1) How to use Wiki to assist the teaching of English writing?
(2) What benefits does it bring?
(3) Under Wiki's assistance, is the writing skill of the students improved? And if yes, from what aspects does Wiki take effects?

This study at first involves 52 students in Class 14, Senior 1 in one middle school in Guangzhou China, with 25 students who participate actively in the experiment chosen for the detailed study. And 3 of these 25 are chosen at random for case study. When the experiment are being carried out, these students has been in Senior One for just one month, however, they all have reached a certain varied level in English.

The three students chosen for detailed analysis are distinguished as Student A, Student B, Student C. Among the 13 groups that the whole class is later divided into, Student A is in Group 4, Student B in Group 7, and Student C in Group 12.

We also randomly chooses 25 students from Class 15, Senior 1 in the same middle school as a control group, since the two classes are in the charge of the same English teacher and Class 15 is also a parallel class in the grade.

The study applies Wiki in the teaching of English writing, by asking the students to finish the collaborative English writing task after class. The data collected from the Wiki are studied and analyzed by adopting the quantitative approach and the qualitative approach.

In order to find out the answers to the research questions, the study is carried out in the following steps:

Step 1: Divide the students into 13 groups of 4 members. Introduce Wiki to the students, and teach them how to operate it online by entering the page of their own groups;

Step 2: Design the writing task, and ask the students to finish the task on Wiki after class; after reaching the deadline, study their first drafts carefully and copy them down;

Step 3: Give some guidelines to the students and ask them to go online again, editing, rewriting, assessing or giving suggestion to theirs or their group members' first drafts;

Step 4: Collect the edited version of the students and other data, and then give time to the students to study their edited version carefully, and in the mean time, give some comments or suggestions to their second drafts as well;

Step 5: Ask the students to finish a writing task again on the base of the first two drafts.

Step 6: Collect the students' final products, get all the data and give feedback.
The procedure that the students involved in can be illustrated as follows (Fig. 1):

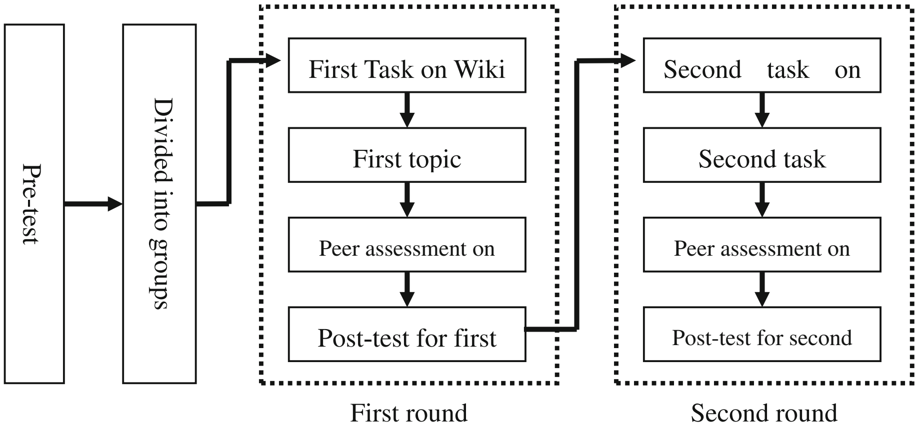

Fig. 1. Procedures of the study

4 Data Analysis and Discussions

According to the results of the students' entrance exam and the interview of their English teacher, we can see that this experimental class is a parallel class among the whole 15 classes, and their English proficiency is relatively lower than other classes'. However, whether the experimental group' scores have obvious difference from the control group or not needs to be analyzed. The study analyzes these two samples by using the Independent-Sample T-Test and gets the following result:

The result shows that the English proficiency of the two groups has no obvious difference before the experiment ($t < 1$, $p > 0.05$) (Table 1).

Table 1. Independent-sample T-Test of pre-test

Group	N	Mean	Std. deviation	*t*	Sig. (2-tailed)
Experimental	25	8.166	1.862	−0.394	0.214
Control	25	8.030	1.760	−0.053	0.230
$^*p < 0.05$					

Under the guidelines of the study, the whole group is divided into 5 groups, and each member of the groups puts up his or her first draft of the first writing assignment on the Wiki pages. The screen capture below is Student B's first draft (Fig. 2):

On the basis of the first draft, the students learn from each other's work, then edit and revise others' works as well as their own. Below shows Student B's revised versions (Fig. 3):

Where have you been? In the last summer holiday, my classmates and I went to shanghai. It was a big beautiful city. My friend and I went to many famous places to visit. Chenghuang Miao Temple is one of the most famous places. We ate many things, those were so delicious! Then in the evening, we had Huangpu River Cruise by ship. It was so beautiful to look at the buildings at night! In the ship, we tough to the foreigners and took many photos. In the talk, we knew that the foreigner went to shanghai to have a holiday with his family. Then he introduced his wife to us and told us they had two big houses, five cars, one daughter and one son. To our surprises, his houses were so big and just like two big villas! At last, we went to Jinmao Tower . But in the beginning, we wanted to visit The Oriantal Pearl's Tower, the guide told us that the tower was too old to go to the top of the tower slowly. When the lift door closed, I felt the lift went very fast! I stood on the top of the Jinmao Tower , oh! The building was so high and I felt a little afraid! Shanghai was a beautiful city! That was a wonderful holiday in my life!

Fig. 2. Student B's first draft of the first writing task

Where have you been?
~~In~~ In the last summer holiday, my classmates and I went to shanghai. It was a big and beautiful city. My ~~friend~~ friends and I went to many famous places to visit. ~~Chenghuang~~
Chenghuang Miao Temple is one of the most famous places. We ate many things, those were so delicious! Then in the evening, we had Huangpu River Cruise by ship. ~~It~~
It was so beautiful to look at the buildings at night! In the ship, we ~~tough~~ talked to ~~the~~ foreigners and took many photos. In the ~~talk, we~~ Conversation,we knew that the ~~foreigner~~ foreigners went to shanghai to have a holiday with his family. Then he introduced his wife to us and told us they had two big houses, five cars, one daughter and one son. To our ~~surprises,~~ surprise, his houses were so big and just like two big villas!
~~At~~ At last, we went to Jinmao Tower . But in the beginning, we wanted to visit The Oriantal Pearl's Tower, the guide told us that the tower was too old to go to the top of the tower slowly. When the lift door closed, I felt the lift went very fast! I stood on the top of the Jinmao Tower , oh! The building was so high and I felt a little afraid!
Shanghai was a beautiful city! That was a wonderful holiday in my life!
31

Fig. 3. Student B's revised version

Table 2. Quantity of errors in writing task II

	Student A	Student B	Student C
Errors in the translation works	9	8	10
Errors having been revised on Wiki	14	17	20

During the second writing task, students are asked to revise the sample writing on Wiki which contents 27 errors. These errors are of the same types that the students made in their former writing. Table 2 shows the quantity of errors each student made in the respective writing version for the second writing task.

For Student A's first draft of the second task, he makes 9 errors. However, in the error correction on Wiki, he and his group-mates revise 14 of the 27 correctly. Student B's group finds out 17 errors and corrects them. The total number of errors which Student C and her group-mates find out and correct is 20. From the data we can see that the students start to be sensitive to the errors in the writing. And by finishing the tasks on Wiki with their group mates, they can learn from each other and correct the errors they made before.

After two rounds of experiments on Wiki, all students are required to take part in the mid-term exam that can be considered as an evaluation for the students' writing skill after the experiment. We study their English writing proficiency by analyzing the data of this exam. By using SPSS, the result of the Independent-Sample T-Test for analyzing the two samples which are respectively the writing scores of the 25 students in class 14 who participated actively in the experiment and the writing scores of the control group is as follows (Table 3):

Table 3. Independent-sample T-Test of post-test (mid-term exam)

Group	N	Mean	Std. deviation	t	Sig. (2-tailed)
Experimental	25	9.860	2.0183	2.881	0.005
Control	25	8.613	1.8145	2.812	0.007

*$p < 0.05$

We can see from the figure, mean of experimental group is higher than that of the control group (9.860 > 8.613). The result shows that, the English proficiency of the two groups has obvious difference after the experiment (p = 0.005 < 0.05). It can be safely concluded that in the mid-term exam, the writing proficiency of the 25 students in Class 14 is obviously higher than the control group.

From all the results above, we could find out that, with the help of Wiki, students of the experimental group are making progress. And their writing proficiencies are obviously being improved. We should also point out that, since the experiment is carried out in limited time, the effects of Wiki may not be obvious enough. And only about 25 students play an active role in the experiment, so only the scores of these 25 students can reveal the truth. That's why we chooses to do the T-test between the scores of these 25 students and the control group, but not between the whole Class 14 and the control class.

5 Discussion

The adoption of Wiki in teaching English writing should be determined by Wiki's own characteristics. Since the assignment is to be finished online, the writing task should be well designed in advance. An interesting and familiar topic can always motivate students to have much more to write and cooperate more closely. Because of Wiki's openness, everyone can go online and see the content. The teacher must make a detailed group arrangement and give guidelines. In order to keep the privacy, students can use their student numbers to log in. Everyone can edit the Wiki page, so it needs to arouse students' awareness of respecting each other's works. The process of writing on Wiki is a process for students to cooperate with each other and learn the writing skills from each other, so collaboration is important. At the same time, showing respect for the comments or correction from peers is also the essential element to the normal operation on Wiki. The teacher should also give feedback regularly so as to help students write effectively.

The application and practice of Wiki in teaching Collaborative English writing shows that Wiki helps to solve the traditional problem in teaching English writing. Firstly, it saves the teacher a lot of time in correcting the compositions. By asking the students to do peer assessment on Wiki, teacher has no need to go over all the first drafts carefully. From the revised version and the history record, the teacher can immediately know how well the students have done and give feedback in time. Secondly, it increases the efficiency in teaching English writing. Students just need to go over several pieces of writing of their group mates. So peer assessment is usually more detailed since they have more time relatively than the teacher. Students as the readers of their peer's writing can find out more detailed problems if their English proficiency reaches a certain level. With Wiki's assistance, the first drafts and the revised versions are shown clearly with different color, so the teacher can quickly know whether or not that the students have realized the problems in the writing and revised them correctly by referring to the history record.

For the students, writing online would allow them to proceed at their own rates. Wiki provides them an environment for collaboration. Correction and collaboration through modeling create a low-anxiety atmosphere. In the process of writing, students learn how to cooperate with each other. And collaboration helps to activate their minds and they can share more ideas. With more readers, they are motivated to write actively and carefully, so as to present their best works to their peers. Writing on Wiki is a long process, students need to revise and review their writing from time to time to make it perfect. By practicing, students can also form a good habit in the process-oriented writing. The formative assessment here can be realized by assessing students' participation on Wiki, the improvements on their writing and their contribution to others' works. So students no more worry about failing in the course caused by failing to achieve a good mark for only one writing task. This relaxes them and encourages them to write.

The results of the experiment on Wiki show us that, to a certain degree, the students' English writing skill has been improved.

Basically, by collaborating on Wiki, students help each other to avoid basic language errors, like misspelling of words, abuse of punctuation, neglect of capitalization, etc.

Furthermore, practicing on Wiki encourages students to write correct and appropriate sentences according to grammar rules. Since it allows students to edit and revise their writing, they are no longer afraid of making errors, and they write down bravely whatever comes to mind. Process-oriented writing gives the learners opportunities to revise their writing again and again so as to make it perfect. In such a process, the participants learn through the frequent making of errors in an online non-threatening environment. Actually, errors are encouraged because they can help with learning by enforce students' impression. By reading others' writing, they may find out the errors they have made and then correct it. This can also help to deepen the impression of grammar rules. The revising records provided by Wiki also give students a clear overview map for their own writing process, so as to guide their future writing.

For the longer term, by writing on Wiki, students can share their ideas and writing skills. This activates their minds. They form the habit to think creatively and gradually develop their thoughts. They may come to different sentence structures or transformations, and may have more choices of words and phrases. So they need to learn to select, organize and order the relevant information.

As many researches support, writing is interactive and is improved by feedback from both teachers and peers. Peer assessment enabled on Wiki is important for exposing students to more readers, comparing with the traditional writing course that teacher is expected to be the only reader. Learners build the confidence as writers and cultivate the ability to manipulate phrases and sentences and use language. Comments and correction from peers are impressed and easily absorbed. When students become the readers, they go through the pieces of writing with critical thinking. Discovering other's errors in the writing brings them a sense of achievement, at the same time, they will intend to avoid such errors and use the correct form of the target language in their own writing.

6 Conclusion

In this study, we prove that collaborative learning can be realized by the participants at different time in different places. This kind of learning encourages students to learn outside classrooms. By applying Wiki in teaching collaborative English writing, teachers ask students to finish the writing task online collaboratively. In such an environment, learners provide assistance to each other, share their ideas and develop more positive peer relationship and higher self-esteem, even academic achievement. Collaboration also enhances learners' social communicative ability.

The study is carried out on a process-oriented basis. With Wiki's characteristics, students' writing process is presented clearly. And the target language is learnt through student's repeated working and reworking. However, process-oriented writing always takes students quite a long time to finish a task. So how to keep the enthusiasm of the students and what kind of topics suit this writing mode best are still to be discussed.

In this study, formative assessment is realized with the help of Wiki. Assessment for students' learning of writing shouldn't be done only by the final products. Instead, we assess learning through the students' writing process. With Wiki's assistance, the author know what the students have learnt in the writing process and whether they have improved their learning or not. Peer assessment also turns out to be a rewarding feature of Wiki. Revisions, comments and suggestions from peers can help learners to find out problems of their own writing, thus improve their writing skills.

Nevertheless, Wiki now has not been widely used for teaching English writing. That's because there're still some limitations of applying Wiki to teaching. On one hand, to apply Wiki to outside-classroom teaching requires students to own personal computers and have Internet access; but at present, not every family can afford this. On the other hand, there are still some limitations on Wiki itself, since working on Wiki is not yet as convenient as on other text-editing software like Word, and the history-record function of Wiki needs to be improved to make it more orderly and clearly. However, with the development of modern technology, the popularity of computer and the efforts of all the educators and relevant researchers, the author believes that all these problems will be well solved.

To conclude, the application of Wiki to teaching English writing gives learners the opportunity to collaborate with each other, thus to improve their writing ability and the competence of using the target language. However, writing on Wiki is a learning process which consumes time and energy. To take effects, it needs both teacher and learners to participate patiently for a long term, especially, with the writing task and administration of Wiki to be well designed.

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A Study of Scientific Inquiry Activities in Smart Classrooms of a Primary School

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Abstract. As inquiry is not only an approach, but also the goal of scientific learning, cultivating students' ability of inquiry in learning science subjects becomes a key element of the new curriculum reform. Smart classrooms, which may facilitate learning activities to enhance students' ability of independent learning, inquiry and creativity, offer a new direction in designing scientific inquiry activities. Based on the theory in activity and constructivism, this study analyzes the key elements of scientific inquiry activities in smart classrooms of a primary school and defines a mechanism for the six types of scientific inquiry activities identified. *Investigation* is one of the six types of scientific inquiry activities. This study analyzes how activities of *investigation* work and be supported in a smart learning environment. Experimental results indicate that investigative inquiry activities in a smart classroom can raise learning achievements, develop the ability of inquiry, and improve the investigative ability, scientific attitude and emotion.

Keywords: Scientific inquiry activities · Investigation inquiry activity · Smart classrooms · E-schoolbag

1 Introduction

"*Science learning should be focused on inquiry*", as stated in the *Science Curriculum Standard* [1] and thus scientific inquiry becomes one of the important elements in the current educational reform of primary science curriculum. How to develop science inquiry instruction effectively has become a hotspot of science education research. However, the value of inquiry instruction has not been reflected in primary science classes yet. Most inquiry activities merely scratch the surface of inquiry [2] due to limiting inquiry resources and environment. Some teachers do not plan for inquiry teaching until they have finished traditional knowledge teaching [3], who do not have a clear understanding of the relationship between the inquiry process and content [4].

Smart classrooms are a kind of smart learning environment which aims to cultivating students' intellectual ability by means of functional supports of information technology associated with reforming the teaching and learning process [5]. Smart

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classrooms may support ubiquitous learning and big-data-based multi-dimensional teaching evaluation, develop wisdom in teaching and learning [6] and improve students' abilities and awareness in self-learning, inquiry, questioning and summary [7]. Thus smart classrooms may provide a new way for the effective implementation of scientific inquiry.

1.1 Review of Scientific Inquiry in Primary Schools

Research on scientific inquiry activities mainly focuses on activity design, optimization strategy, ability development and assessment. Han [2] studied the design strategy of scientific inquiry activities in a primary school under the context of Internet of Things. Zhang [8] explored the optimization strategy of scientific inquiry activities in a primary school from the following four dimensions in presentation: target, content, statement and assessment. Yang [9] discussed the relationship between models of scientific inquiry in classrooms and the development of scientific inquiry abilities of students. Timothy [10] researched on the meta-cognition and self-adjustment strategy of students in scientific inquiry teaching. Han [11] explored the effect on the development of students' scientific literacy after conducting web-based scientific inquiry.

These researches on scientific inquiry are undertaken from multiple perspectives. As a result of educational informatization in China, there are more smart classrooms available. How to design and integrate scientific inquiry activities in this smart learning environment so as to improve students' scientific literacy and wisdom is a topic that deserves further study.

1.2 Review of Smart Classrooms

Smart education is a result of the "Smarter Planet" strategy since its proposal by IBM in 2008. *Smart classroom* becomes a core element of smart education. Researches in this area mainly focus on the definitions, features and construction strategy of smart classrooms, tools and platforms supported by various technologies, survey on its acceptance and effectiveness of smart classrooms, etc.

Tang *et al.* [5] analyzed the associated teaching characteristics after integrating teaching into smart classrooms. Pang *et al.* [12] constructed a smart classroom with the use of e-schoolbag for primary English classes and studied the impacts of e-schoolbag on classroom teaching. Sun *et al.* [13] explored teaching procedures in smart classrooms with experimental results and conducted dynamic learning assessment utilizing some emerging technologies like big data. Jena [14] found that students learning in smart classrooms outperformed the traditional classrooms with a sample size of around a hundred of primary students. Kim [15] conducted a survey on teachers' intention to use smart APP in smart classrooms of a primary school. Jeong [16] studied the writing and co-production of media for smart classrooms.

In general, few studies have focused on the teaching models, methods, activities and evaluation of specific subjects of teaching and learning in smart classrooms. Hence, designing scientific inquiry activities of smart classrooms is desirable.

In this paper, we review the current practice of scientific inquiry activities and smart classrooms; analyze the mechanism of scientific inquiry activities of smart classrooms in a primary school; and report the effect of investigation – a specific type of scientific inquiry activity with experiments.

2 Analysis of Mechanism and Types of Scientific Inquiry Activities of Smart Classrooms in a Primary School

2.1 Theories in Activity and Constructivism

Theory in activity starts with an "activity" and aims to understand the mental capabilities associated with activities of individuals [17]. Engeström *et al*. [18] further developed the activity theory after Vygotsky to make it more operational.

Theory in activity offers useful guides in a framework for the development of scientific inquiry activities, in which it concerns students' participation and cooperation, creation of an activity situation, the purpose and intention of activities, the process and results. Theory in activity stresses the intermediary role of tools, thus smart learning environment can provide a strong support for the scientific inquiry activities undertaken.

Constructivism is a theory of knowledge in which human generates knowledge and meaning from interactions between their experiences and their ideas [19]. Communication, collaboration, situation and meaning construction are the four key elements of constructivism.

Carrying out inquiry activities in science classes is in line with constructivism's student view and learning view. The purpose of inquiry activities is to facilitate students to construct scientific knowledge by active exploration [20]. Hence, it is important to study on interactions and communications of each element, especially between subject and situation in the scientific inquiry activities.

2.2 Analysis of Mechanism of the Scientific Inquiry Activities of Smart Classrooms in a Primary School

"Mechanism" can be defined as the structure and working principles of a machine or the structure and relationship between elements of organisms [21]. Based on the latter explanation, we aim to define the mechanism of scientific inquiry activities of smart classrooms in a primary school, in which elements and their relationship of scientific inquiry activities are specified.

2.2.1 Analysis of Elements of Scientific Inquiry Activities of Smart Classrooms

According to the theory in activity, an activity system consists of six elements: object (or objective), subject, mediating artifacts (signs and tools), rules, community and division of labor [22]. Xie [23] suggested that there were several factors contributing to a learning activity: learning target, activity task, learning method and its associated procedure, interaction style and group format, the form of learning outcomes, rules, roles and responsibilities of activity monitoring, and learning evaluation criterion. Han [2] indicated that scientific inquiry activities in a primary school with Internet of things include four factors: target, environment, process, and evaluation.

The scientific inquiry activities of smart classrooms [5] can be considered as an activity system including seven factors: subject of exploration, target/object of exploration, smart learning environment, strategy/rule of exploration, process of the scientific inquiry activities, achievement of the scientific inquiry activities, and evaluation of the scientific inquiry activities.

The subject of exploration as an elementary unit of scientific inquiry activities, could be individual students or learning groups; the target/object of exploration is the target of influence and change through inquiry activities; smart learning environment serves as mediation tools; the strategy/rule of exploration is used to support and guide students to carry out scientific inquiry activities; the inquiry process is the procedure of blended scientific inquiry activities in smart learning environment with the guidance of teachers; inquiry achievement is the learning outcomes of inquiry activities; evaluation is the judgment on the process and outcomes of the activities.

2.2.2 Mechanism of Scientific Inquiry Activities of Smart Classrooms

Interpretative Structural Modeling (ISM), a research method to reveal the internal structure of a system by analyzing the relationship among its elements [24], is used to find out the mechanism of scientific inquiry activities of smart classrooms.

S1 to S7 symbolized the seven factors of the scientific inquiry activities in a smart learning environment: subject of exploration (S1), target/object of exploration (S2), smart learning environment (S3), strategy/rule of exploration (S4), process of the scientific inquiry activities (S5), achievement of the scientific inquiry activities (S6), and evaluation of the scientific inquiry activities (S7).

While the theory in activity suggested a goal-oriented and hierarchical structure, combined with interactions via mediation tools [25], constructivism emphasize interactions among factors in the learning system, especially subject and situations. This study analyzes this relationship in a scientific inquiry system. The result, as shown in Fig. 1, indicates that the inquiry strategy is generated by target/object of exploration; target/object, subject, strategy/rule of exploration and smart learning environment contribute to building the process of scientific inquiry activities; the achievement of scientific inquiry activities is determined by how a subject learns in smart learning environment and is evaluated according to the object.

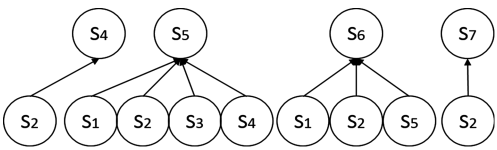

Fig. 1. The relationship among the 7 factors

The hierarchy of the elements in scientific inquiry activities is showed in Table 1 and Fig. 2 displays the mechanism of scientific inquiry activities of smart classrooms in a primary school as a relationship model.

Table 1. The layer of the elements

Layer	The elements
4	S_6,S_7
3	S_5
2	S_1,S_3,S_4
1	S_2

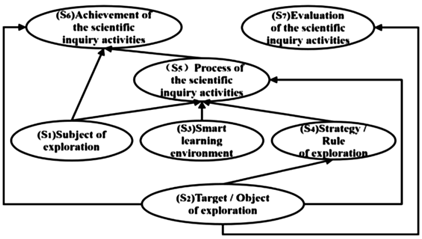

Fig. 2. Mechanism of scientific inquiry activities of smart classrooms in a primary school

As shown in Fig. 2, the elements of scientific inquiry activity system could be divided into four layers.

In the first layer, the target/object of exploration (S2) is the starting point, providing guidance to the strategies, process, achievement and evaluation of the scientific inquiry activities of smart classroom in primary school.

In the second layer, the subject of exploration (S1) is students who will be divided into learning groups with the intervention of teachers; smart learning environment (S3) consisting of not only the physical environment but also software environment with learning resources, supports the scientific inquiry activities; the strategy/rule of exploration (S4) is the guarantee factor designed by teachers to ensure the smooth running of the scientific inquiry activities.

In the third layer, the process (S5) of the scientific inquiry activities is carried out according to rules and strategies (S4) developed under the guidance of object (S2). Individual students and learning groups (S1) follow such process (S5) of blended scientific inquiry activities in smart learning environment (S3).

In the fourth layer, the achievement (S6) of the scientific inquiry activities is the learning outcomes of the inquiry groups, embodying the completion status of activities and the goals set before; the evaluation (S7) of the scientific inquiry activities checks quality of the outcomes derived from the process (S5) according to the target (S2) of the inquiry activities; such evaluation can provide basis of invaluable feedback to the subject (S1).

We can see that the process of scientific inquiry activities is the core element and the smart learning environment has great effect on the inquiry activities from the mechanism of scientific inquiry activities of smart classrooms in a primary school. We suggest that the support of the smart learning environment in the scientific inquiry activities is mainly reflected in the following aspects:

(1) Inspiring thinking and asking questioning: The smart learning environment provides many forms (such as images, texts, radios, videos, etc.) of personalized resources that are visual, interactive and adaptive so as to create complex problem situations to inspire students asking questions.
(2) Deepening interaction and communication: The smart learning environment may create a problem and communication situation and construct a "field" for the virtual learning community to interact,communicate, discuss and complete knowledge construction and generation through these activities.
(3) Providing inquiry tools: The smart learning environment may provide various tools from 3D printer and wearable devices to mind map tools, audio and video editing software, etc.
(4) Recording inquiry process: A large amount of data that can be obtained through recording the process inquiry activities of all students and this data forma a basis for the evaluation of learning outcomes.
(5) Supporting multiple evaluations: Smart classrooms big-data-based learning analysis does not only record students' learning history, but also analyze students' learning effect by of data-mining technologies [26].

2.3 Types of Scientific Inquiry Activities of Smart Classrooms

The scientific inquiry activities can be divided into different types according to the different target of inquiry. The *National Science Education Standards* [27] articulated that the scientific inquiry is a variety of activities that students acquire knowledge, comprehend scientific ideas, understand the methods used by scientists to study nature, which includes observation, measurement, manufacture, conjecture, experiment and communication. *Science curriculum standard* for compulsory education indicated that scientific inquiry activities include information collection, on-site observation, natural observation, experiment, case study, scenario simulation, scientific production, discussion and debate, planting and breeding, scientific game, information conference, visit, competition, science appreciate, community science activity, family science and technology activities, role playing, science fiction [1]. Fu *et al*. [28] divided scientific inquiry activities into operational experiment, idea experiment, visit and investigation, discussion and communication, materials research according to scientific curriculum, as well as instructive inquiry, cooperative inquiry and open inquiry depending on the classroom organization format.

Following the mechanism of scientific inquiry activities of smart classrooms in a primary school as discussed in Sect. 2.2 and different goals of scientific inquiry, we divide the scientific inquiry activities of smart classrooms in primary school into six categories, including *observation*, *investigation*, *experiment*, *discussion and debate*, *scientific game*, and *scientific ideal implementation*, as shown in Fig. 3.

Different kinds of the scientific inquiry activities of smart classrooms in a primary school have different mechanism. Investigation is taken in this study to further analyze its mechanism and the support by smart learning environment.

(1) The mechanism of investigation. Investigation is an approach to learn perceptual knowledge, whose goal is to analyze the effect or find the relationship among things. According to different investigation approaches, investigation can be classified into direct investigation and indirect investigation. Direct investigation can be considered as on-the-spot investigation, while indirect investigation is a survey method through visiting, questionnaires, data access, etc. [29].

In Investigation, the collaborative inquiry team is the subject, and the smart learning environment is a powerful support providing photographing and data processing tools. Scaffolding strategy and interaction strategy can be used during the inquiry process, in which the questionnaire design and data analysis require special attention to ensure its reliability and validity. Investigations inquiry activity should be organized in an online-offline hybrid way and the result is often presented in the form of a survey report. The teacher evaluates the survey process and the survey report according to the investigation object, meanwhile, students can also conduct self-assessment and peer assessment in such platform.

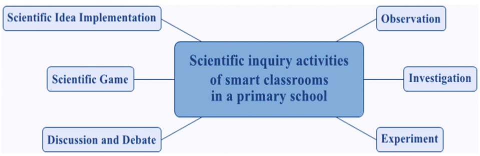

Fig. 3. Types of scientific inquiry activities of smart classrooms in a primary school

(2) Specific supports of a smart learning environment are in various forms. E-schoolbag and cloud platform in a smart learning environment may help students develop and share a program of inquiry. Online survey tools and voting systems in e-schoolbag support smooth *investigation*. Data collecting and processing is also supported by online statistical systems and visualization tools in e-schoolbag. BBS and message boards may help students communicate and share online.

3 Implementing the Scientific Inquiry Activity - Investigation

Teachers should arrange and organize the six types inquiry activities (*observation*, *investigation*, *experiment*, *discussion and debate*, *scientific game*, and *scientific ideal implementation*) flexibly based on the teaching goal, teaching content, and mechanism in a smart classroom. Due to the time constraints, this study carried out quasi-experimental research taking *investigation* only as an example, and verified the effect of *investigation* in a smart classroom of a primary school. Research design and experimental process are described as follow.

3.1 Research Design

3.1.1 Object of Research

We invited 92 grade 6 students of Shiken Primary School in Nanhai District of Foshan City in Guangdong province to join our experiments. Class 1 containing 47 students was the experimental class while Class 2 was the control class containing 45 students. The learning achievement, scientific attitude and emotional value of these students were more or less the same. *Diversity of organism* was a typical unit of *investigation* with 3 lessons (*Biological search in campus*, *a wide variety of plants*, and *we are in different appearance*) chosen randomly in this experiment.

3.1.2 Experimental Scheme

The post-test of both groups were carrying out after activities for *investigation*. The experimental group carried out *investigation* in a smart classroom (independent variable X) in this experiment, and we aim to see if there is any change in students' scientific inquiry literacy (dependent variable Y). The experimental class carried out hybrid *investigation* in a smart classroom which supported by the *Zhaoyang Class* platform and e-schoolbag, while the control class carried out offline investigation in a traditional classroom during the process of experiment. After 3 lessons, we analyzed the effect of *investigation* by testing students' scientific literacy.

3.1.3 Measurement Tools

This study defined scientific literacy as "scientific knowledge", "ability of inquiry" and "scientific attitude and emotion" according to the *Science Curriculum Standard* [1] and Miller's [30] three-dimensional model of scientific literacy. Taking *investigation* as an example, its effect was analyzed through the three attributes "scientific knowledge", "investigative ability" and "scientific attitude and emotion".

3.2 Experimental Process

The experimental class carried out hybrid *investigation* in a smart classroom while the control class carried out offline investigation in a traditional classroom in this experiment. Taking the lesson *we are in different appearance* in the unit of *diversity of organism* as an example, we designed two progressive in-depth *investigations* according to the defined mechanism to be used in the smart classroom which was supported by the *Zhaoyang Class* platform and e-schoolbag.

In the experimental class, the goal of the first *investigation* aims to ask students to understand characters of their classmates. Individual student was the subject of investigation. Every student was required to survey the character of a classmate around, to take and upload photos, and to complete the "Questionnaire 1". The teacher provided students with the necessary scaffolds. Students could take photos, take online statistics, visualize data and communicate via functions provided in e-schoolbag. Under the guidance of objective of the *investigation*, the teacher evaluated the survey result (Questionnaire 1) together with students' self-assessment and peer assessment on the cloud platform.

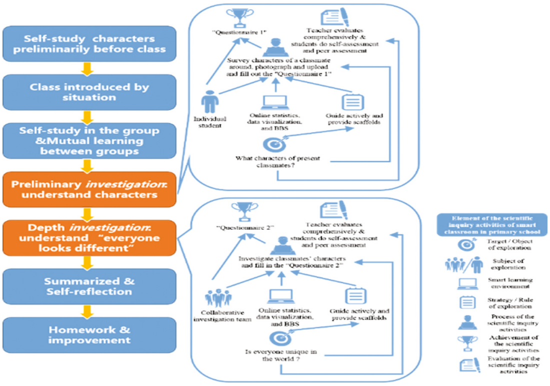

Fig. 4. Instruction flowchart of *we are in different appearance*

In order to enable students to better understand "everyone looks different", the teacher organized the second *investigation* in the class. Students investigated classmates' characters, filled in "Questionnaire 2" via e-schoolbag with from the teacher. The survey result (Questionnaire 2) was evaluated by the teacher, students could also do self-assessment and peer assessment on the cloud platform. The specific teaching process and investigation activities mechanism are shown in Fig. 4.

In the control class, students understood their own characters through mirrors, and observed classmates' characters to understand "everyone looks different".

4 Evaluation

Data collected through tests and questionnaires was analyzed. We judge students' mastery of the scientific knowledge by their scientific achievement. After experiments, all students participated in a unified scientific knowledge quiz and results of these two classes were presented as independent samples t. We then make a questionnaire to measure the investigative ability, scientific attitude and emotion in the experimental class. The questionnaire consists of 18 questions measured with a 5-point Likert-type scale ranging from "strongly disagree (–2)" to "strongly agree (2)". The data was processed in two-dimensional scale: $F_i = \sum a_j n_{ij} / 2N$. The result shows that students' scientific knowledge, investigation ability, scientific attitude and emotion are improved after taking *investigation* in smart classrooms of a primary school.

4.1 Science Achievement

The quality of students learning is shown in Table 2. The results of independent samples t-test show that there is significant difference with probability $p = 0.049 < 0.05$, indicating that there are significant difference in achievement between the experimental class and the control class.

Table 2. Independent samples t-test of students' science achievement

Achievement	Levene's test for equality of variances		t-test for Equality of Means						
	F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std. Error Differece	95 % Confidence interval of the difference	
								Lower	Upper
Equal variances assumed	24.666	.000	2.995	90	.048	3.47376	1.15993	1.16935	5.77817
Equal variances not assumed			2.950	59.093	.049	3.47376	1.11736	1.11736	5.83016

Their average difference was 3.47376, which shows that the average score of the experimental class was higher than that of the control class. Therefore, investigation activities in smart classrooms of a primary school can improve students' scientific achievement in this study.

4.2 Investigative Ability

We examine students' ability of *investigation* from many aspects, such as the hypothesis and conjecture, plan formulation, information collection, design of questionnaire, investigation, interview, explanation and conclusion, expression and communication. Results in Table 3 show that the F_i score of each item in the questionnaire is over 0.5, indicating that carrying out *investigation* in the smart classroom can

Table 3. Students' investigative ability data analysis

	Item	Value
Hypothesis and conjecture	1. With the help of the smart learning environment, I can hypothesis and conjecture better for specific phenomenon	0.59
Plan formulation	2. After using e-schoolbag, I can make plans better in the scientific inquiry	0.50
Information collection	3. I can collect useful information more smoothly by e-schoolbag in the smart classroom	0.74
Design of questionnaire	4. I can design effective questionnaire by referring to the relevant network materials in the smart classroom	0.71
Investigation	5. I can distribute and recover the questionnaire and data processing by cloud platform in the smart classroom	0.70
	6. I can carry out field survey better by e-schoolbag	0.72
Interview	7. I can conduct interview better by e-schoolbag	0.76
Explanation and conclusion	8. I can explain my survey results clearly by data visualization software in the smart classroom	0.67
Expression and communication	9. I can express my ideas in the class forum when I have a new science fiction	0.78

enhance students' investigative ability. But the F_i score of "hypothesis and conjecture" and "plan formulation" item is 0.59 and 0.5, suggesting that improvement is not obvious in these two items. It is possibly related to students' inherent thinking and behavioral habits. More efforts are required in these areas.

4.3 Scientific Attitude and Emotion

Students' scientific attitude and emotion were investigated via the following 8 aspects: interest and curiosity, suspicion and criticism, innovation, independence, equality, cooperation, social responsibility, STS (Science, Technology and Society). All F_i values in Table 4 are positive indicating that there are changes in their scientific attitude and emotion. However, the F_i values of "suspicion and criticism" item is 0.52 only, showing that students' skepticism and critical spirits need more efforts. The F_i values of "STS" item is 0.42, significantly lower than others, indicating understanding the influence of science on society and spirit of serving the society by science are weak.

Table 4. Students' scientific attitude and emotion data analysis

	Item	Value
Interest and curiosity	1. I prefer to learn science after entering the smart of the classroom	0.84
	2. I prefer to explore the causes of various phenomena in the natural world after a period of study in the smart classroom	0.82
Suspicion and criticism	3. I don't quite believe that the knowledge in the textbook is completely correct by smart learning environment	0.52
Innovation	4. After using e-schoolbag to explore, I have more novel ideas and prefer to create works	0.64
Independence	5. I prefer to complete independently many inquiry tasks on books in the smart classroom	0.66
Equality	6. I have same opportunity to participate in the experiment when conducting a group experiment in the smart classroom	0.68
Cooperation	7. I prefer to complete inquiry with students in the smart classroom	0.68
Social responsibility	8. I would be happy to participate in water conservation or tree planting activities, if there are students invited me in the class forum	0.67
STS	9. I don't think science can help me in daily life	0.42

5 Conclusions

This study analyzed elements and mechanism of scientific inquiry activities of smart classrooms in a primary school. In this mechanism, the process of the scientific inquiry activities is carried out according to rules and strategies developed under the guidance of object. Individual students and learning groups follow such process of blended scientific inquiry activities in a smart learning environment. The process of scientific inquiry activities is the core element and the smart learning environment is the technical support. The inquiry activities are classified into *observation*, *investigation*, *experiment*, *discussion and debate*, *scientific game*, and *scientific ideal implementation*. The teaching practice shows that carrying out *investigation* in smart classrooms in a primary school can effectively raise students' science achievement, enhance the investigative ability, and improve their scientific attitude and emotion.

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Developing the 3G3L Instructional Model for Primary Chinese Supported by E-Schoolbag

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Abstract. Primary Chinese curriculum focuses on the formation and development of students' Chinese accomplishment. However, there are issues and difficulties in primary Chinese instructions. The application of e-schoolbag provides a new way for the reform of primary Chinese instruction. This study systematically analyzed the main functions of e-schoolbag supporting instructions for primary Chinese literacy, reading and writing. In order to improve the instructional quality of primary Chinese, this study developed the 3-Guidance (3G) and 3-Learning (3L) instructional model for primary Chinese supported by e-schoolbag. There are 3 ways of guidance (3G) from teachers, including *guide to stimulate interest*, *guide to learn diversely*, and *guide to in-depth practice*. There are also 3 ways of learning (3L), including *independent learning*, *cooperative learning* and *expansive learning*, with the support of e-schoolbag in a three-stage learning cycle consisting of before class, during class and after class. Results show that instructional practice applying the 3G3L model can stimulate student's learning interest, improve achievement in literacy, reading, and writing, and thus the overall quality in Chinese.

Keywords: 3G3L instructional model · Primary Chinese · E-schoolbag

1 Introduction

Chinese at primary level is a comprehensive and practical course, which does not only allow students grasp the mother tongue language for communication, development of logical thinking and building up the language sense but also develop abilities of literacy, reading and writing in meeting practical requirements [1]. However, current primary Chinese education still has problems such as outdated teaching methods, lack of theoretical research [2]; unified instructional format and reading materials, low student participation and weak learning interest, large class size with individual difference, difficulties in achieving individuation reading [3]; using traditional instructional model and lack of teaching practice with multimedia [4] and so on.

New Media Consortium Horizon Report [5] believes that e-schoolbag is a technology which may have significant influence to future learning science development. E-schoolbag comes into classrooms as the current development in educational

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informatization in China. Researches and practices show that its rich media, interactivity and mobility can provide supports for primary Chinese instruction. In this study, we aim to investigate the development of an innovative instructional model with the use of e-schoolbag in primary Chinese instruction and study its effectiveness.

2 A Review on Primary Chinese Instruction with E-Schoolbag

The implementation of the new curriculum reform is an innovation of education concepts which aims to turn a dull classroom into a lively one with vitality. The new curriculum reform advocates that teachers have a dominant role to inspire and guide with an aim to develop students to learn independently, cooperatively and exploratively. Current research of primary Chinese instruction mainly focuses on problems on teaching practice and teacher adaptability, etc. Problems in primary Chinese instruction appear in multiple perspectives such as weakening the leading role of teachers [6], blindly expanding the amount of literacy [7], ignoring reading comprehension and emotional experience but focusing on recitation [8], neglecting exploration of ideas and imagination [9] and so on; teachers not adapting to changes in role and behavior psychologically [10]. Since the new curriculum reform brought many challenges to primary Chinese instruction, exploring primary Chinese instructional model during the new curriculum reform is of great importance.

On the other hand, research on e-schoolbag applications in primary Chinese instruction mainly focused on functions of e-schoolbag and instructional design supported by e-schoolbag. E-schoolbag in Chinese writing and reading lesson can create situations, convey resources, group divisions and peer interactions and communication [11]. Lv *et al.* [12] conducted instructional design supported by e-schoolbag platform taking practical lesson *Couplet* as a case. Lian [3] studied ways of applying e-schoolbag in Chinese reading instruction and analyzed their effectiveness through classroom observation, questionnaire and interview. Su [13] suggested that using e-schoolbag can change Chinese instruction view, enrich instructional practice and enhance effectiveness. Gong [14] also stated that the dynamic presentation of learning resources provided multiple learning paths and allowed thought stimulation and thus improved the overall quality in Chinese.

In general, there is an increasing amount of researches of primary Chinese reading and writing in the e-schoolbag environment but insufficient researches on instructional models in primary Chinese supported by e-schoolbag, leading to what we intend to discuss in this paper.

3 Development of the 3G3L Instructional Model

3.1 Rationale

Chinese at primary level is a comprehensive and practical course, as stated in the *Primary Chinese curriculum standards* [1], which serves as a tool for communication and for studying humanities. The primary Chinese curriculum aims to enable all pupils to obtain the basic abilities in mastering the Chinese language including *literacy, reading*, and *writing*, adapting to the need of real life.

Literacy instruction is the basis of reading and writing. It is the key teaching element at the beginning of the curriculum with important contents to support the entire compulsory education. The *primary Chinese curriculum standards* request teachers to use a variety of visual and intuitionistic teaching methods, which can be activity-based or game-based with focuses on pinyin, stroke, structure, and radical of Chinese characters and on the unity of sound, form and meaning of a word [15].

Reading instruction is important in language teaching language for pupils to obtain information, to develop thinking and to appreciate aesthetic experience. Instructions in reading should focus on cultivation of pupils' ability of feeling, understanding, appreciation and evaluation; and should facilitate both reading aloud and silent reading, so as to equip pupils with intensive reading, skimming and browsing at a later stage. Efforts are required in cultivating pupils' reading interest, expanding their reading scope, increasing the reading quantity, and improving taste.

Writing instruction is an important way of teaching expression and communication with a focus on cultivating pupils' ability of observation, thinking, expressing and creating, via practicing skills on topic selection, conception, drafting, and processing. Pupils may also improve the ability of writing through the process of critiquing and modifying the work of one's own and of the peers.

In motivating pupils to learn actively, the flipped classroom theory was adopted which turns a traditional "teaching-centered" teaching practice into asking pupils to read learning materials and to watch videos before engaging in tasks or experiments in classes [16]. The pre-lesson preparation enables pupils to concentrate more on initiatives of the project-based learning in class. Pupils may plan their own learning contents and paces. Teachers' instruction may response to the problems raised by pupils after self-study before class.

3.2 Functions of E-Schoolbag Supporting Instructions of Primary Chinese

Previous works [17, 18] suggested functions of e-schoolbag to support the building of problem situations, autonomic learning, group cooperation, targeted guidance, developmental evaluation, and knowledge management. The functions in e-schoolbag to support instructions of primary Chinese literacy, reading and writing were described below.

3.2.1 Supporting Literacy Instruction

Literacy instruction aims to achieve unity of sound, form and meaning of a word. The rich learning resources in the forms of images, animation in e-schoolbag may improve the effectiveness of literacy instruction more. Following is a list of specific features:

(a) *Smart reading and writing*. Intelligence may be supported in e-schoolbag by providing personalized reading and writing. Pupils may follow pronunciations in learning to read and orders of strokes in learning to write supplied by the e-schoolbag.

(b) *Glyph demonstration*. E-schoolbag can provide glyph animation in the order of strokes of a word, so as to master writing a Chinese character.

(c) *Word meaning presentation*. E-schoolbag can present the origin, meaning and evolution of a word.

(d) *Spelling game*. E-schoolbag can provide word games in enhancing pronunciation.

3.2.2 Supporting Reading Instruction

Reading instruction is the dialogue among pupils, teachers, textbook editors, text. The process of e-schoolbag can help pupils to intensive read, skim, browse and deepen pupils' understanding and experience. It causes the pupil to obtain enlightenment thought and enjoy the aesthetic. Specific features are:

(a) *Personalized pushing*. E-schoolbag can push appropriate reading materials to pupils who can put forward comments when encountering difficulties or acquiring further reading materials from e-schoolbag.

(b) *Discussion and interaction*. This function may facilitate teacher-pupil and peer discussion about problems they encounter in the process of reading. Wonderful clips, original understanding of an article and emotional experience in reading may also be shared.

(c) *Test in time*. This function provides timely tests on the ability and effectiveness of intensive reading, skimming and browsing; analysis of the test results; and leading to a more targeted training on obtaining the reading level of pupils.

(d) *Resource management*. The rich reading materials in various formats are managed in e-schoolbag.

3.2.3 Supporting Writing Instruction

Writing instruction should facilitate pupils practicing writing by allowing them easy to write, and willing to express about life and reality. E-schoolbag can establish inspiring writing situations with writing ideas. Specific features are as below:

(a) *Writing scenario*. Rich materials in e-schoolbag such as figure, text, sound and image may help to create vivid and inspiring writing scenarios to pupils; who can in turn create new scenarios by searching and taking photos and videos.

(b) *Sharing and communication*. Pupils may display their composition in the discussion area and learn from each other, especially the good essay.

(c) *Multi-dimensional evaluation*. Teachers can mark and comment on pupils' composition and there is a voting function for pupils to select the best composition. Peer evaluation and interactive modification are supported.

3.3 An Overview of the 3G3L Instructional Model

3.3.1 Objectives

Previous works [18] proposed the e-schoolbag supported flipped classroom model in three stages: before class, during class and after class, which is based upon the existing "practice-assessment-stress" teaching model of PZ 3rd Junior High School for review lessons in junior mathematics. This study further proposes a 3G3L instructional model in primary Chinese supported by e-schoolbag with the direction of *Primary Chinese curriculum standards* [1] and flipped classroom theory. The 3G3L Instructional Model considers pupils have a dominant role in learning but roles of teachers in providing guidance and mobilizing their initiatives and enthusiasm in learning cannot be neglected [19]. With the adoption to the flipped classroom approach, the development of the 3G3L instructional model aims to realize such approach into the instructional model; to design teaching practice for primary Chinese with supports from e-schoolbag; and to evaluate the effectiveness of this model.

3.3.2 The Process

In order to improve the instructional quality of primary Chinese, we developed the 3-Guidance and 3-Learning (3G3L) instructional model for primary Chinese supported by e-schoolbag (as shown in Fig. 1) as result of analyzing the instructional goals, objects and contents. There are 3 ways of guidance from teachers including *guide to stimulate interest*, *guide to learn diversely*, and *guide to in-depth practice;* and requiring students to have 3 ways of learning including *independent learning*, *cooperative learning* and *expansive learning* with the support of e-schoolbag in a three-stage learning cycle consisting of before class, during class and after class.

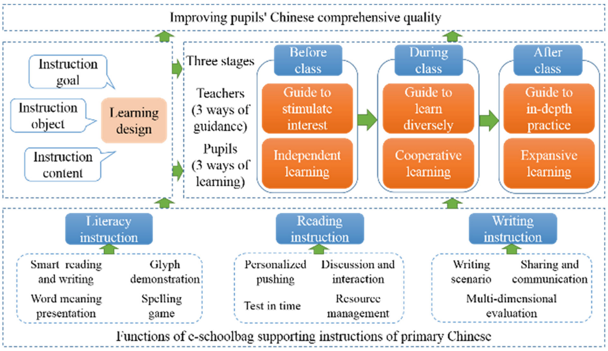

Fig. 1. The 3G3L instructional model in primary Chinese supported by e-Schoolbag

Stage 1: Before class. Teachers may create learning scenarios and problems to solve packaged with related resources of literacy, reading and writing send to pupils via e-schoolbag. Pupils are requested to learn independently before the class and send feedback to teachers when encountering difficulties in self-study.

Stage 2: During class. Teachers guide learning activities during class according to different characteristics of instructions for literacy, reading and writing; and adjust these learning activities based upon feedback from pupils before class. Pupils can learn collaboratively under the guidance of teachers.

Stage 3: After class. Teachers guide in completing exercises may be obtained via the e-schoolbag after class. Students may also be ask to collect their own resources from the Internet such as how a word evolving, little stories in helping the words etc. These learning resources can be shared via e-schoolbag. Teachers can also provide a variety of scenarios for capable pupils.

3.3.3 The Three Ways of Guidance

In this model, teachers follows the 3 guidance (3G) teaching practice: *guide to stimulate interest*, *guide to learn diversely*, and *guide to in-depth practice* in the literacy, reading and writing instruction supported by e-schoolbag.

(1) *Guide to stimulate interest.* In the literacy instruction, there is a lot of interesting literacy resources in the e-schoolbag like prerecorded micro lessons in various forms such as songs of explaining new words, which can be used to stimulate pupils' interest and read independently. And then, prepare the exercises according to the relevant knowledge and students' cognitive structure. In reading instruction, personalized reading materials may be provided to pupils according to preference of pupils together with some questions to guide students in searching for information of various aspects of the reading materials such as background and author introduction. Stimulating interests with problem scenarios is most effective during writing instruction. Teachers may provide writing materials relevant to the subject matter or may supply initial writing themes and ask pupils to search for relevant information such as photos or videos an aim to stimulate or inspire pupils in writing.

(2) *Guide to learn diversely.* In the literacy instruction, a variety of leaning resources makes learning diversely possible. Pupils may choose words to learn at their own pace by watching glyph animation, following the order of stroke in writing and listening and practicing pronunciation. Teachers may test new words by spelling games. During reading instruction, pupils may share their views in reading or wonderful sections of an article, which may facilitate pupils to read in different perspectives. In the writing instruction, teachers can guide pupils to upload and share their own composition to allow peer learning and critiquing.

(3) *Guide to in-depth practice.* In the literacy instruction, pupils are encouraged to collect information about the evolution of new words, to create doggerels, nursery rhyme and small stories of new words, and to share them with teachers and classmates. In reading instruction, teachers may provide expansive and comprehensive exercises and encourage pupils reading with feeling. In the writing instruction, writing practice on real life topics leads to the discussion of various skills.

3.3.4 The Three Ways of Learning

Pupils are encouraged to carry out *independent learning*, *cooperation learning* and *expansive learning*, knowing as the 3 learning (3L) in this model.

(1) *Independent learning*. Pupils are encouraged to learn independently and complete learning tasks in literacy, reading, and writing on e-schoolbag before class. Pupils can decide when and where to study learning materials repeatedly. Personalized learning may be achieved if the level of competence of pupils in reading is captured by e-schoolbag. Pupils may ask for helps from teachers and from peers through the e-schoolbag and platforms when a problem comes up.

(2) *Cooperative learning*. Pupils have to complete learning tasks arranged by teachers during class. While pupils may watch glyph animation, word meaning presentations and playing word games by companion exercises, group competition, group discussion, and other forms, they encourage participating actively in reading sharing, composition posting, peer evaluating and interactive modifying of writing in a cooperative manner.

(3) *Expansive learning*. Expansive learning after class can be achieved by pupils studying additional learning materials or exercises through various learning activities like collecting homophones, synonyms and antonyms of words, so as to improve the overall quality in Chinese.

4 Experiment and Effect Analysis

This experiment in Shaxuyi Primary School was carried out for a period of one year, with instructional practice adopting the 3G3L instructional model of primary Chinese supported by e-schoolbag as described in the last section. The experiment and effect analysis are described as below.

4.1 Experimental Design

4.1.1 Experimental Purpose

The purpose of this study is to verify the effectiveness of the 3G3L instructional model of primary Chinese supported by e-schoolbag, reflecting in changes in the interest in learning Chinese, literacy scores, reading scores, writing scores and the overall scores.

4.1.2 Subjects and Contents

The subjects of the experiment are pupils 2 classes of Grade 4 pupils, where Class 3 (44 pupils) is the experimental class and Class 2 (43 pupils) is the control class. The contents in the experiment are 16 units in two volumes of the fourth grade primary Chinese published by the PEP (People's Education Press) with a total of 64 texts.

4.1.3 The Hypothesis

The 3G3L model supported by e-schoolbag can better improve pupils' interest of learning Chinese; the literacy scores; the reading scores; the writing scores and the overall scores of primary Chinese.

4.1.4 Design of Experimental Process

The experiment used the investigation method to analysis the influence of using the 3G3L model supported by e-schoolbag on pupils' interest in learning Chinese, and used quasi-experimental research methods that pretesting and post-testing the unequal experimental group and control group to test the changes of pupils' learning results of literacy scores, reading scores, writing scores and the overall performance. The design of quasi experimental was shown in Table 1.

Table 1. Quasi-experimental research methods that pretesting and post-testing the unequal experimental group and control group

Pretest (R1～R2)	Groups	Experimental treatment	Posttest
R1	Experimental class Class 3 Grade 4	Receiving	R3
R2	Control class Class 2 Grade 4	Not receiving	R4

4.2 Analysis of Data

4.2.1 Pretest

In July 2013, the experimental class and the control class took part in the final test organized by the Panyu district, and the test results were used as the pretest data. The pretest data was analyzed by independent sample T-test, showing in Table 2.

Table 2. Independent sample T-test for pretest

		Levene's test for equality of variances		T-test for equality of means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std. Error difference	95 % Confidence interval of the difference	
									Lower	Upper
Literacy scores	Equal variances assumed	24.666	.000	2.995	90	.052	3.47376	1.15993	1.16935	5.77817
	Equal variances not assumed			2.950	59.093	.051	3.47376	1.11736	1.11736	5.83016
Reading scores	Equal variances assumed	18.103	.000	2.361	85	.061	2.48150	1.05095	.39193	4.57107
	Equal variances not assumed			2.345	62.134	.062	2.48150	1.05815	.36637	4.59663
Writing scores	Equal variances assumed	23.037	.000	2.740	85	.057	3.31871	1.21128	.91036	5.72706
	Equal variances not assumed			2.718	56.644	.059	3.31871	1.22104	.87329	5.76413
Overall scores	Equal variances assumed	14.754	.000	2.141	85	.053	2.15592	1.00696	.15382	4.15802
	Equal variances not assumed			2.127	64.151	.057	2.15592	1.01342	.13146	4.18038

We can see from the independent sample T-test for pretest that probability of significant difference in literacy scores, reading scores, writing scores and the overall scores ($p = 0.051 > 0.05$, $p = 0.062 > 0.05$, $p = 0.059 > 0.05$, $p = 0.057 > 0.05$), indicating that there is no significant difference between the experimental class and the control class.

4.2.2 Posttest

(1) *The interest in learning Chinese*. This research investigated pupils' interest in learning Chinese in the experimental class after using the 3G3L model supported by e-schoolbag for one year. The results were shown in Table 3.

Table 3. The results of the investigation of pupils' interest in learning Chinese

Item	The percentage (%)		
	Agree	Neutral	Disagree
1. I hope to use e-schoolbag in Chinese class	93.18	6.81	0
2. After using e-schoolbag, I think Chinese class is more interesting	95.45	4.55	0
3. After using e-schoolbag, I am more active in the class	93.18	4.54	2.27
4. I like to use e-schoolbag to study Chinese after class	86.36	6.81	6.81

According to the statistical results, there are more than 93 % pupils who agreed to all the questions, indicating that the 3G3L model supported by e-schoolbag can stimulate pupil's interest to study Chinese. While, there are only 86.36 % pupils that like to use e-schoolbag to study Chinese after class, which requires further attention.

(2) *Literacy scores*. In July 2014, the experimental class and the control class took part in the final test organized by the Panyu district again after the one-year experiment, and we used this test results as the posttest data. The results of independent sample T-test of literacy scores are shown in Table 4.

Independent T-test results show that there is very significant difference between the experimental class and the control class ($p = 0.009 < 0.01$). The average of the

Table 4. Independent sample T-test of literacy scores for posttest

Literacy scores	Levene's test for equality of variances		T-test for equality of means						
	F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std. Error difference	95 % Confidence interval of the difference	
								Lower	Upper
Equal variances assumed	9.814	.002	2.698	85	.008	2.39112	.88618	.62916	4.15309
Equal variances not assumed			2.688	75.410	.009	2.39112	.88964	.61903	4.16321

experimental class is 2.39112 which is higher than that of the control class, indicating that the 3G3L model supported by e-schoolbag can better improve pupils' literacy scores.

(3) *Reading scores*. The results of independent sample T-test of reading scores are shown in Table 5.

Table 5. Independent sample T-test of reading scores for posttest

Reading scores	Levene's test for equality of variances		T-test for equality of means						
	F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std. Error difference	95 % Confidence interval of the difference	
								Lower	Upper
Equal variances assumed	17.414	.000	3.151	85	.002	3.01903	.95798	1.11432	4.92374
Equal variances not assumed			3.136	70.559	.002	3.01903	.96279	1.09906	4.93899

As shown in Table 5, there is significant difference of reading scores between the experimental class and the control class ($p = 0.002 < 0.05$). So we can say that the 3G3L model supported by e-schoolbag can better improve pupils' reading scores.

(4) *Writing scores*. The results of independent sample T-test of writing scores are shown in Table 6.

Table 6. Independent Sample T-test of writing scores for posttest

Writing scores	Levene's test for equality of variances		T-test for equality of means						
	F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std. Error difference	95 % Confidence interval of the difference	
								Lower	Upper
Equal variances assumed	1.872	.175	2.426	85	.017	2.50264	1.03151	.45172	4.55357
Equal variances not assumed			2.423	83.558	.018	2.50264	1.03281	.44862	4.55666

The results show that there is significant difference of writing scores between the experimental class and the control class ($p = 0.017 < 0.05$), so that the 3G3L model supported by e-schoolbag can better improve pupils' writing scores.

(5) *Overall scores*. The results of independent sample T-test of overall scores are shown in Table 7.
As we can see, there is very significant difference of overall scores between the experimental class and the control class ($p = 0.000 < 0.01$). We can come to a conclusion that the 3G3L model supported by e-schoolbag can better improve pupils' the overall scores of primary Chinese.

Table 7. Independent sample T-test of overall scores for posttest

Overall scores	Levene's test for equality of variances		T-test for equality of means						
	F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std. Error difference	95 % Confidence interval of the difference	
								Lower	Upper
Equal variances assumed	20.729	.000	3.847	85	.000	3.76321	.97826	1.81817	5.70826
Equal variances not assumed			3.827	69.317	.000	3.76321	.98345	1.80145	5.72498

4.3 Experiment Results

As a result of analyzing the experimental data, we found that the 3G3L model supported by e-schoolbag effectively stimulated pupils' interest in learning Chinese, significantly improve the literacy scores, the reading scores, the writing scores and the overall scores after the one-year experiment, which verified the experimental hypotheses.

5 Conclusion

During the current curriculum reform exercise, primary Chinese instruction puts more emphasis on transformation on teaching and learning ideas of attitudes and methods. E-schoolbag, as a kind of smart learning environment, provides supports to the reform of primary Chinese instruction. This study suggested teaching practice on primary Chinese instruction with supports from e-schoolbag functions and developed a 3G3L instructional model.

In literacy instruction, functions of e-schoolbag mainly include *smart reading and writing*, *glyph demonstration*, *word meaning presentation*, *spelling game*; In reading instruction, e-schoolbag's functions mainly include *personalized pushing*, *discussion and interaction*, *test in time*, *resource management*; In writing instruction, functions of e-schoolbag mainly include *writing scenario*, *sharing and communication*, *multi-dimensional evaluation*.

This study proposed the 3-Guidance and 3-Learning (3G3L) instructional model in primary Chinese supported by e-schoolbag with the guidance of the *primary Chinese new curriculum standard* and the flipped classroom theory. There are 3 ways of guidance from teachers including *guide to stimulate interest*, *guide to learn diversely*, *guide to in-depth practice* and requiring students to have 3 ways of learning including *independent learning*, *cooperative learning* and *expansive learning* with the support of e-schoolbag in a three-stage learning cycle consisting of before class, during class and after class.

Experimental results shows that the 3G3L model supported by e-schoolbag can stimulate pupils' learning interest, improve achievement in literacy, reading, and writing, and thus the overall quality in Chinese.

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Collaborative Teaching Approaches: Extending Current Blended Learning Models

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Abstract. This study reviewed Horn and Staker's framework of blended learning and addressed the need for categorizing recently initiated collaborative teaching approaches to blended learning. Due to the rapid pace of technological development, this study proposed an expansion of the currently accepted blended learning model to include three newly emerged joint teaching models: (1) on-site leadership, (2) off-site leadership, and (3) co-teaching. Through a series of case study analyses, best practices and strategic opportunities for each new model were discussed.

Keywords: Blended learning · Collaborative teaching · Case studies · Joint teaching models · On-site leadership · Off-site leadership · Co-teaching

1 Introduction

Technology has displayed profound influenced over education and blended learning has been a favorable outcome of the integration between technology and education [1–3]. It has been widely accepted that blended learning incorporates both formal face-to-face and technology-based education whereby the modalities of learning are interconnected [4–10]. The National Education Association has defined blended learning as, a learning environment integrating a combination of face-to-face and technology-based instruction with a licensed teacher that focuses on student needs and provides students with an extended degree of control over time, place, path and/or pace of learning [6].

Through combining a variety of delivery vehicles, models of teaching, and styles of learning, blended learning offers the possibility for educators to reinvent teaching and learning [6]. However, the rapid pace of technological development has itself allowed the emergence of new, innovative, and dynamic opportunities for blended learning which were never previously feasible to conceptualize.

As educational fields move toward differentiation and personalization, the focus on blended learning is increasing [11]. Therefore, in order to foster a better understanding of the ongoing blended learning transformation, this study (1) reviews the existing blended learning models and (2) proposes an extended model of categorization in account for newly emerging forms of collaborative teaching approaches.

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2 Overview of Existing Blended Learning Models

Horn and Staker [4] categorized the definition of blended learning into four widely recognized models: (1) rotation, (2) flex, (3) a la carte, and (4) enriched virtual. All of these models incorporate formal education with part-time content and instructional delivery from both formal traditional and online education environments; however, each model is designed to achieve success under differing educational conditions. The following is a brief overview of Horn and Staker's widely accepted blended learning models, which were believed to conclusively summarize blended learning developments at the time of their publication and mostly focus upon concepts of individual teacher leadership.

The rotation model is a variety of teaching approaches whereby students are led through activities that incorporate at least one online learning component. This model is further organized into four sub-categories: (1) individual rotation, (2) station rotation, (3) lab rotation, and (4) flipped classroom. Individual rotation offers customized activity lists based on personalized needs. Station rotation is the equal distribution of student experience through a completely unwavered rotation of all students through all existing stations. Lab rotation is a physical rotation of space, for example to a computer lab for online learning components, and the flipped classroom is where students participate individually in off-site online learning in order to free time for practical application during the traditional on-site class.

The flex model is a teaching approach where student learning is based online, however, students' customized schedules include offline activities and the teacher(s) of record is on-site in an as-needed or adaptive capacity. The a la carte model is a teaching approach where students participate in a few fully online courses that compliment and run parallel to traditional face-to-face learning experiences. The enriched virtual model is a teaching approach where students are required to attend some face-to-face teaching with a teacher of record, however, then students are free to complete their work at a self-paced basis off-site.

Congruent to their definition of blended learning [4], Staker and Horn recognized the importance of definitions within emerging fields [10]. As without a common language, it is much less efficient for researchers and practitioners to discuss, expand, and refine new phenomena [9]. It has been recognized by the forthcoming case studies that rapid technological progress has changed the landscape of blended learning and require an extension of the current [4] blended learning model. It is now known that newly emerging joint teaching approaches to blended learning exist, however, it is not clear how these newly emerging approaches can fit into the existing framework. Horn and Staker's framework very clearly outlined initial models of blended learning, however, due to available technological resources at that time, the models primarily focused on individually-led teaching and learning practices. While there is some room for collaborative teaching within the existing framework's definitions, the roles and responsibilities of co-teaching initiatives, where possible, are less clearly defined than individually-led teaching roles and responsibilities.

The merits of collaborative teaching are well documented to provide widespread beneficial impacts: to students by stimulating higher achievement, greater retention, improved interpersonal skills, and positive independence; and to teachers by providing opportunities to learn and reinforce new styles of teaching, and overcome the frequent sense of isolation [12]. Therefore, due to the significance and magnitude of potential benefits within emerging collaborative approaches of blended learning, the authors would like to propose, organize, and introduce, an expansion of [4] blended learning model that includes "joint teaching" whereby education is categorized by collaborative management of more than one certified teacher within a single course subject on a regular day-to-day schedule.

3 Newly Emerged Blended Learning Opportunities

As seen in Fig. 1, the proposed expansion model of blended learning includes not only existing teaching models, but also three newly emerging joint teaching models which were previously unavailable. These new collaborative approaches have become available due to rapid technological developments and do not clearly fit into any of the existing blending learning models. The names of these joint teaching models are: (1) on-site leadership, (2) off-site leadership, and (3) co-teaching. Furthermore, similar to the design of the rotation model's organizational layout, the co-teaching model is proposed to include two sub-categories: (a) digital co-teaching model, and (b) flex co-teaching model.

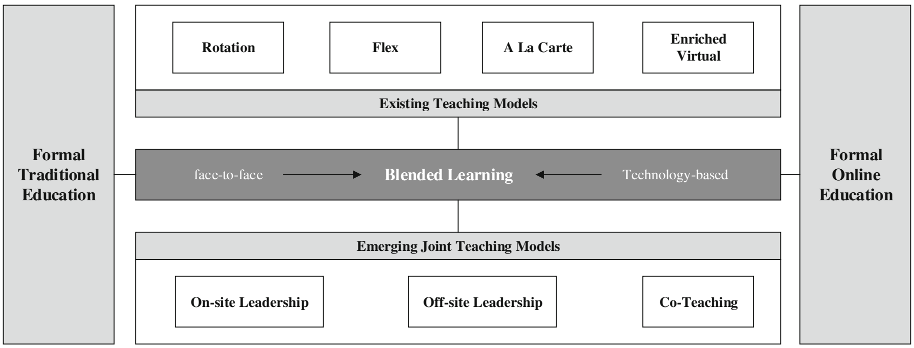

Fig. 1. Proposed expansion of blended learning models

3.1 On-Site Leadership Model

The on-site leadership model represents a scenario where on-site teachers are responsible for organizing course content to include a combination of direct content delivery and digital content delivery. Of the digital content delivery, on-site teachers must identify and select appropriate teaching resources where off-site teachers have supplied their specialized expertise. Students in the classroom learn remotely from off-site teachers via digital technology without extensive interaction with the off-site teacher. Meanwhile, the on-site teacher provides face-to-face guidance and support for students as needed. Additionally, the on-site teacher leads discussions and adjusts teaching schedules according to students' performance. In this model, the on-site teacher is a director in teaching and learning, both selecting resources in designing course scheduling, and managing the face-to-face student interactions. In the meantime, the off-site teacher is a specialized supportive figure. Figure 2 illustrates the on-site leadership model, and identifies the main roles and relationships of each teacher.

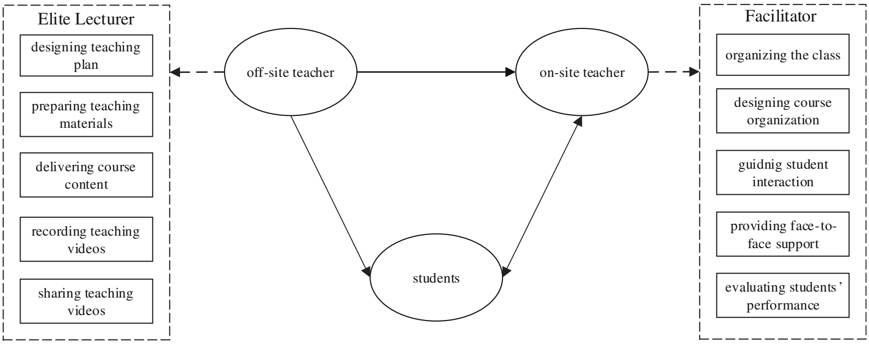

Fig. 2. On-site leadership model

3.2 Off-Site Leadership Model

The off-site leadership model represents a scenario where an off-site teacher, usually located in a geographically distant location from students, delivers instruction throughout the whole duration of a course with the support of at least one additional on-site teacher. However, through this process, the on-site teacher(s) organize students in real-time with a two-way videoconferencing system, or one-way video and two-way audio communication system to enable interaction between the elite lecturer and students. Contrary to the on-site leadership model, the on-site teacher is not directing teaching and learning, but rather facilitating the education process in a supportive role to the master lecturer which is located off-site.

Figure 3 illustrates the roles and relationships between the components of off-site leadership model. The off-site teacher is completely in charge of designing teaching plans, determining teaching methods, preparing teaching materials, and delivering course content. The on-site teacher(s) organize student participation, provide face-to-face student support, and collect and evaluate students' performance. Furthermore, on-site and offsite teachers maintain open communications throughout the duration of the course in order to maintain effective understanding of student performance and schedule lessons accordingly.

3.3 Co-Teaching Models

The co-teaching model represents a course, which is formally co-designed, with equal teacher participation, and co-delivered by two or more teachers that may be

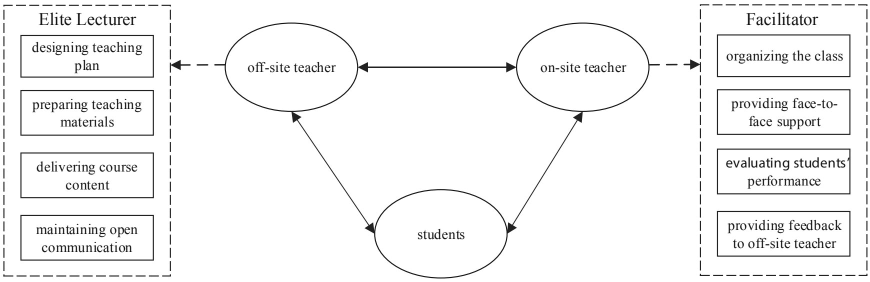

Fig. 3. Off-site leadership model

geographically in different locations within one or more combination of different educational entities. Typically, the co-teaching model connects classes within a school, or between schools for durations agree upon by the instructors. The length of co-teaching durations can range anywhere from a single overlapping module, to the entire duration of the course. While the exact course arrangements are up to instructors, each on-site teacher is responsible for delivering content, and evaluating students' performance in their respective locations. Therefore, it is proposed that this model be sub-categorized into: (1) digital co-teaching and (2) flex co-teaching, to represent varying types of co-teaching collaborations that exist.

Collaboratively designed activities which host student collaborations online due to a geographically distant co-teaching and learning process represent the newly emerged 'digital' category of the co-teaching model. While collaboratively designed activities which host face-to-face interactions for the co-teaching and learning process in the same location would represent the 'flex' category, which is a proposed sub-definition of the previously existing flex model. The sub-category is being proposed due to the recognition that the current flex model broadly offers possibilities for both joint teaching and individually-led teaching approaches. However, the organization of individual and collaborative teaching is vastly different. Therefore, the newly proposed line of distinction would be drawn by the number of co-participating instructors. Individually-led instruction should remain defined by the existing flex model, while

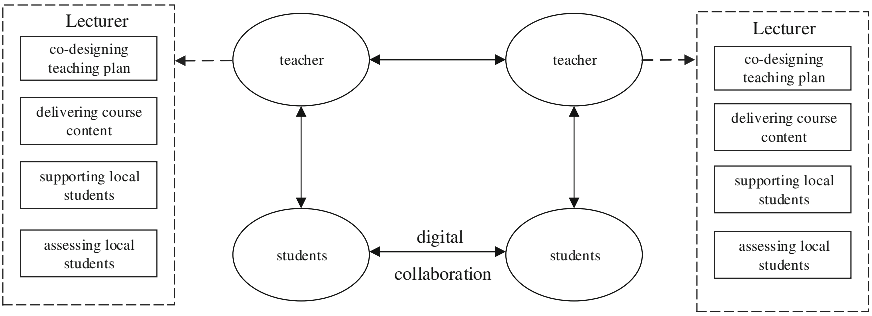

Fig. 4. Digital co-teaching model

collaboratively-led instruction should be recognized parallel to the newly emerging joint teaching models, as it provides a very similar basis of the new definition.

Figure 4 illustrates the digital co-teaching model. Geographically distant teachers co-design overlapping modules of their individual courses to include digital student collaborations. Two or more teachers work together to co-design, and deliver content in their own classes as on-site teachers. Furthermore, the teachers are locally responsible for all necessary communication, support, and assessment.

Figure 5 illustrates the flex co-teaching model. Teachers join their classes in one shared location for co-designed content delivery within a single course. Independent online work is in some capacity incorporated to provide teachers with the necessary time to be available for both traditional face-to-face lecture and targeted strategic intervention of at-risk students as necessary throughout the course. In this model, the teacher managing small group intervention also supervises students working independently online.

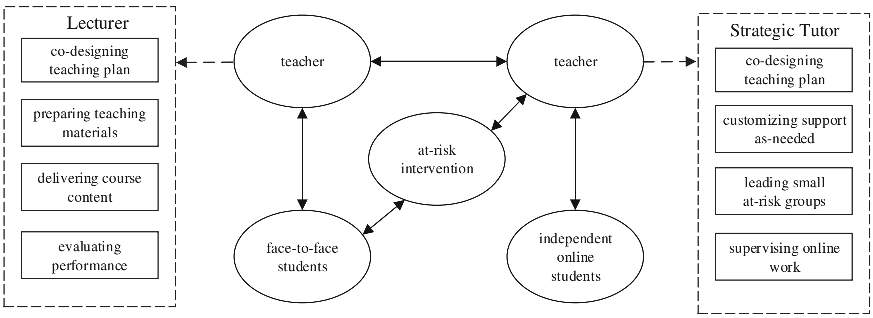

Fig. 5. Flex co-teaching model

4 Case Studies of Joint Teaching Models

4.1 On-Site Leadership Model

Application of Open Online Teaching Units. It is widely acknowledged that open educational resources have created extensive opportunities for unlocking access to quality in a non-geographically dependent manner [13]. Inspired by the Khan Academy's success providing high-quality teaching resources for free in U.S. K-12 education, the application of open online teaching units has been popular in China's K-12 education system. In 2014, in order to promote ICT-empowered teaching and the sharing of high-quality educational resources, China's Ministry of Education implemented the *A Teacher with One Predominant Lesson, A Lesson with One Elite Teacher Program*. This program strives to encourage each primary and secondary school teacher to create at least one lesson to contribute to a database of content for teachers to enrich their classrooms and ensure each classroom utilizes at least one elite teacher's content through ICT. Teachers all over China record the process of delivering course content, then share the videos via a National Educational Resources Public Service Platform, which is evaluated by experts. As of April 14, 2016, a total of 3,028,177 lessons have been shared according to the statistics by the National Educational Resources Public Service Platform [14]. On-site teachers now may search and select lessons that have been assessed for high quality rigor from a huge platform of options, and then combine those high-quality teaching units with the course content delivery. Through this process, students gain access to the most elite teachers via off-site digital instruction. On-site teachers provide students with face-to-face support and guide class interactions. Furthermore, on-site teachers have the responsibilities of evaluating students' performance, and adjusting course schedules as necessary.

The application of open online teaching units strives to provide low cost routes to accessing high quality courses offered by elite teachers. Due to the huge quantities of open online teaching units, on-site teachers can easily select high quality teaching units to incorporate into their classrooms. This newly emerging joint teaching approach to blended learning is extremely important to student success, especially in remote locations. The on-site leadership model both increases education equity through the even distribution of high equality resources and transitions the role of on-site teachers' in education from content creator, to creative director. Furthermore, the development of open online teaching units may also be an effective approach in stimulating teachers' motivation to integrate ICTs in teaching, which is beneficial for promoting the modernization of education.

4.2 Off-Site Leadership Model

The Remote Synchronous Classroom. The *Remote Synchronous Classroom Approach* has been developed in China in order to compensate for imbalanced teaching resource allocations, as it has been widely recognized that there is a deficit of high-quality teaching resources in rural areas, especially among courses of art, music, etc. [15]. A good example of this is the Mao Batang Primary School (MPS), which is a one-teacher school located in a rural area of the Enshi State in Hubei Province. In China, one-teacher school refers to a rural school with only one teacher who is required to teach all students from varying grades levels in all subjects due to the shortage of qualified teachers. The MPS developed a joint teaching collaboration with the Baota Primary School (BPS), an urban school in Enshi State, to implement remote synchronous education. The teachers of BPS deliver teaching content in the classroom, meanwhile, students in MPS learn from the off-site teacher in real time via two-way videoconferencing. Students of both schools learn simultaneously and share high-quality resources.

In this process, students of MPS had the capability of communicating with (1) the off-site teacher, (2) the off-site students, and (3) the on-site teacher. The teacher of BPS answered student questions in real-time, while the on-site teacher provided complimentary face-to-face student support. Mr. Hu, a teacher in MPS stated, "I haven't studied English and music, so it is difficult to deliver content of the courses. With the help of a remote synchronous classroom, students could learn from more elite teachers regarding my weaker subjects" [16].

It is appropriate to employ the remote synchronous classroom between urban and rural schools to improve rural students' access to high quality digital and human educational resources. The off-site leadership model is critical for decreasing the digital divide between urban and rural students. Furthermore, with access to this newly emerging joint teaching approach to blended learning, similar to the on-site leadership model, education equity is greatly promoted.

4.3 Co-Teaching Model

Digital Co-Teaching Model. *Collaborative Online International Learning* (COIL) is a new approach to teaching and learning that brings together geographically distant instructors and students from different lingua-cultural backgrounds to communicate and collaborate through online communication tools [17, 18]. In recent years, this approach has been widely explored by the State University of New York (SUNY) as they continue efforts to internationalize their 64 higher education institutions. A prime example of the digital model of co-teaching is a project host by the SUNY COIL Center, which was funded by the National Endowment for the Humanities (NEH) in 2013. Pilot course collaborations involving 21 institutions globally were initiated, whereby, learning objectives in similar courses of geographically distant locations where identified, then content was co-designed and co-taught by cooperating teachers at each respective institution. Students were asked to work in cross-cultural groups on overlapping course modules or entire courses. In this model, teachers mutually contributed, maintained open communication, and were completely responsible for their local students.

The digital co-teaching model aims to improve communication coherence among students and develop the skills necessary for effective teamwork in the 21st century. Digital co-teaching doesn't need to be international collaborations, however, when they are, students benefit from the exposure to cross-cultural communication in their learning. In this sense, the digital co-teaching model enables students a global experience via communication technologies; while teachers may also learn from sharing teaching philosophies, methods, and experiences through co-designing and co-delivering course content.

Flex Co-Teaching Model. The *Time-Technology Swap*, a flex co-teaching model of blended learning, was pilot at the Rocketship Education Network of charter schools in San Jose, California in 2013. Their approach to the flex model of blended learning was very unique, and worth clearly distinguishing as a turning point in the definition of our terminology. This unique model utilized multiple teachers which co-designed content and co-taught students face-to-face within a single subject matter. This model also utilized a single large and open space for students to all participate in the same experience, regardless of whether they were working independently on computers, working in small groups, or attending a lecture [19]. This is different from many formerly recognized blended learning models because as students were not rotating to different physical spaces (rotation model), teachers were not maintaining a division in course specializations and delivery (rotation model), and teachers were available full-time instead of an as-needed basis (flex model). This design united teaching efforts of multiple teachers by combining identical classes, incorporating digital modules, and sharing the responsibility of teaching design and content delivery. Online activities were used to allow teachers availability for simultaneously hosting a lecture and small focused intervention groups. In this program, multiple teachers were on-site complimenting the teaching and learning process.

The flex co-teaching model is extremely beneficial in providing focused intervention for students at-risk on a customized daily basis. Therefore, this approach may be very attractive for subjects, which often pose difficulties in student understanding and could often benefit from a compliment of focused short-term side-bar support. Furthermore, with the mass-guidance and small group intervention complimenting on-site delivery, the flex co-teaching model presents great potential for customizing the

Table 1. Comparison of joint teaching models

Roles and responsibilities	On-site leadership model		Off-site leadership model		Co-teaching model			
					(flex)		(digital)	
	on-site teacher	off-site teacher	on-site teacher	off-site teacher	on-site teacher	on-site teacher	teacher location 1	Teacher location 2
Designing teaching plan	√			√	√	√	√	√
Selecting resources	√			√	√	√	√	√
Delivering content	√	√		√	√	√	√	√
Real-time student interaction	√		√	√	√	√	√	√
Organizing the class	√		√		√		√	√
Providing face-to-face student support	√		√		√	√	√	√
Evaluating students' performance	√		√		√	√	√	√
Strategic opportunities	Improve access to high quality resources		Improve access to high quality resources		Allow space for focused intervention		Develop team competence & cross-cultural awareness	

learning experience of each student in terms of pace and content according to their interest and motivation.

5 Discussion and Conclusion

The three kinds of joint teaching models vary in structure and responsibility, in response to the purposes they serve. Table 1 benchmarks the various roles and responsibilities of teachers among the featured collaborative models of blended learning, as well as identifies the preliminary strategic opportunities that these models can offer. Critical analysis of the joint teaching models of blended learning offers three main strategic advantages to the classroom. The main strategic advantages that may be realized through proper implementation of these models are: (1) improving student access to high quality educational resources, (2) allowing space for focused student intervention, and (3) improving students' communicational skills, particularly in the areas of cross-cultural awareness.

When moving in the direction of establishing a blended learning approach in a school or classroom, there are a variety of techniques that may support success. First, it is recommended that educators benchmark the current strengths and weaknesses of their classes. Recognize where students are struggling, and what would be beneficial to mitigating these issues. Then, cross analyze this information with the strengths of blended learning models to see if there are options which may offer support to the specific scenario. Finally, if there is interest to move forward toward blended learning implementation, it is recommended to start by picking one resource to engage in on a small-scale pilot [7]. Starting too large in this type of a process may be overwhelming and unproductive in providing the desired benefits.

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Content Development

Investigating the Effects of Visual Cues in Multimedia Instruction Using Eye Tracking

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Abstract. This study employs eye-tracking technology to investigate the effect of visual cues in multimedia-based, self-directed online instruction. Eye tracking data such as fixation time, fixation count, and movement trails were collected to document how participants directed their attention during their online learning process. Compared with the learning experience without visual cue presence, this study provides empirical evidence on how visual cues affect online learners' learning pattern, learning experience, and learning outcome, and proposes tentative guidelines for designing effective multimedia instructional content for online or blended learning environments.

Keywords: Visual cues · Eye tracking · Multimedia instruction · Instructional design

1 Introduction

Multimedia instruction can be defined as instruction that uses at least two types of media forms to present instructional content [1]. The advancement of computer technologies nowadays makes it easier to integrate text, audio, still image, motion graphic, and videos in a single instructional unit, resulting in more commonly use of multimedia in both online and face-to-face instructional contexts. Well-designed multimedia instruction is considered to be more cognitively stimulating and engaging than text-only instruction [2], and can result in better learning outcomes [3, 4]. However, the mere presence of multimedia does not ensure superior performance from learners [2, 5]. In fact, several studies have proved it might have detrimental impact on learning due to extraneous cognitive load caused by multiple instructional modalities presented at the same time [6, 7].

One technique to enhance the effectiveness of multimedia instruction is to use visual cues to guide the learning process. Visual cues are visual signals in the forms of color transition, emerging shapes (e.g. arrow, line, circle, and box), pop-up captions, or other visual effects that highlight selected information or direct learners' attention to a

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specific content area. Visual cues are believed to bring many positive effects on learning, including: faster reaction time [8], better comprehension of key information and relationship [9, 10], enhanced information recall [11, 12], and knowledge transfer [13]. However, it is important to note that the existing research on visual cues are often based on subjective data such as researchers' observation and learners' self-report, and thus many claimed effects of visual cues are in need of more rigorous validation using more objective data [5].

To address such research need, this study investigates the effect of visual cues in multimedia instruction by analyzing learners' physical eye data collected from an eye-tracking device. The study aims to provide additional evidence on the effects of visual cues and propose guidelines for employing visual cues in multimedia instructional content. More specifically, this study seeks to answer the following research questions:

1. How does the presence of visual cues affect learners' online learning pattern?
2. How do learners respond to and interact with visual cues during online learning?
3. How does the use of visual cues affect learners' recall of instructional content?

2 Method

2.1 Participant

The Participants were 8 graduate students from the School of Education in S University in United States, who responded to the research request and agreed to participate in the study. As future educators, they were also the target audience for the multimedia instructional content selected for the study. No specific efforts were made to control the demographic variables of the research participants since the multimedia instruction is completely online therefore is accessible for anyone. As a result, the participants differed in gender, age, nationality and educational background. The basic information of the participants is summarized in Table 1. Real names for all participants were changed to ensure the anonymity of the study.

Table 1. Basic information of the participants

Code	Name	Groups	Gender	Age	Nationality	Background
T-1	Julie	Treatment	F	25	China	ESL
C-2	Carrie	Control	F	21	U.S.	Elementary. Edu
T-3	Laura	Treatment	F	40	U.S.	Edu. Leadership
C-4	Huang	Control	M	26	China	Edu. Technology
T-5	Ming	Treatment	M	28	China	Edu. Technology
C-6	Michelle	Control	F	38	U.S.	Curriculum
T-7	Andy	Treatment	M	30	S. Korea	Edu. Psychology
C-8	Debbie	Control	F	33	Brazil	Inclusive Edu.

2.2 Multimedia Instruction

The multimedia instruction selected for this study was adapted from an online tutorial (https://courseware.e-education.psu.edu/cbi/tutorial2/story.html). The tutorial uses cases from an exemplar enrichment program to teach learners how to design and facilitate similar programs that develop key academic and digital skills for children in program projects and activities. There are a total of four instructional units selected for the study (Fig. 1). Unit 1 explains how to introduce a program project by showing previous student works; Unit 2 explains the four criteria for creating a poetry puzzle (one of the projects) with a student's example; Unit 3 demonstrates how a student successfully integrated brainstorming ideas into a story; Unit 4 showcases how students worked in teams to film a short movie.

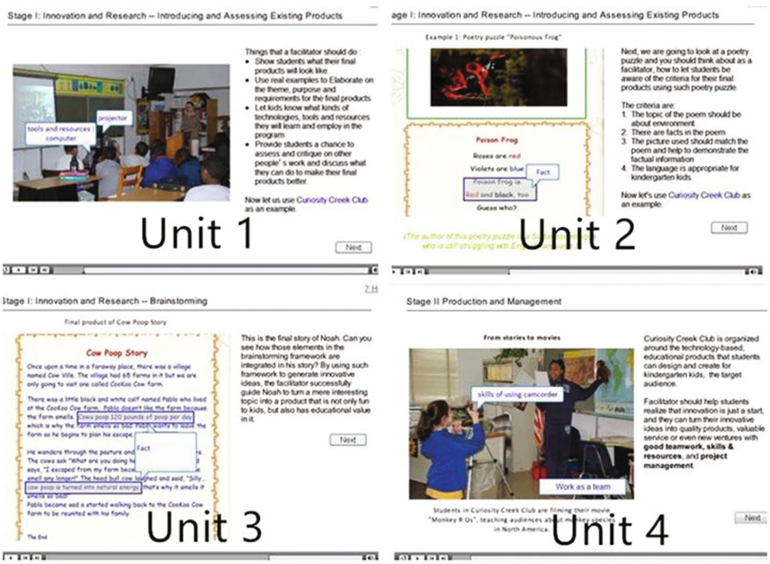

Fig. 1. Four instructional units in the multimedia instruction

As shown in Fig. 1, the tutorial has a side-by-side layout: text content on the right describes the general concepts and principles of how to design and facilitate program activities and projects, while the image content on the left presents authentic examples from the exemplar program to further explicate or elaborate on the text content. Visual cues were presented in the forms of emerging captions, highlight boxes, and character shadings on top of the image content to provide additional information and emphasize the connection between text content and image content.

2.3 Procedure

Participants were randomly assigned to two groups (4 for treatment group and 4 for control group), with the treatment group receiving the instructional content with visual cues and the control group receiving the instructional content without visual cues. Each participant studied the instructional content individually on a desktop computer, which was linked to an eye-tracking device − EyeLink1000. Participants had their pupil image and corneal reflection calibrated and validated before the study to ensure the estimation of eye position accurately match the known position on the desktop computer screen.

For treatment group, four sets of visual cues started to appear after 15 s into an instructional unit, with each set of cues lasting for about 5 s. Thus the maximally allowed time for studying each unit for treatment group was 35 s. Since there were no visual cues for control group, the study time for each unit was slightly shortened to adjust for such difference, allowing control group participants to spend maximally 25 s to study a unit. As a result, the maximally allowed study time was 150 s for the treatment group and 120 s for the control group.

Two test questions were presented at the end of session to assess learner's retention and comprehension of the tutorial content. Participants need to recall six key points in order to answer the test questions correctly. There was no time limit set for answering the questions, but all participants submitted their answers within one minute. Participants' answers were graded by the researchers, and the grading results were analyzed using SPSS.

MATLAB was used to setup the tutorial interface, present instructional content as a set of stimuli, set up the time and sequence for each stimulus, and record participants' responses and eye data. In summary, there are four major types of data collected in this study, which are:

1. Total count of eye fixation for each instructional unit
2. Distribution of eye fixation on the tutorial interface
3. Eye movement trails during the entire learning session
4. Participants' written responses to the two test questions

3 Results

3.1 Effect of Visual Cues on Online Learning Pattern

The general learning pattern for both the treatment group and the control group were visualized using heatmap (see Fig. 2). Heatmap displays different levels of eye fixation intensity in various colors, with "hot color" indicating high intensity and "cold color" indicating low intensity. As shown in Fig. 2, the treatment group seemed to divide their attention more equally to both text and image content, as indicated by the count of eye fixations on both right (text) and left (image) side of the computer screen. In fact, more heat spots can be found on the image side and their positions overlap with the visual cue positions, proving visual cues were effective in attracting and keeping learners' attention during learning process.

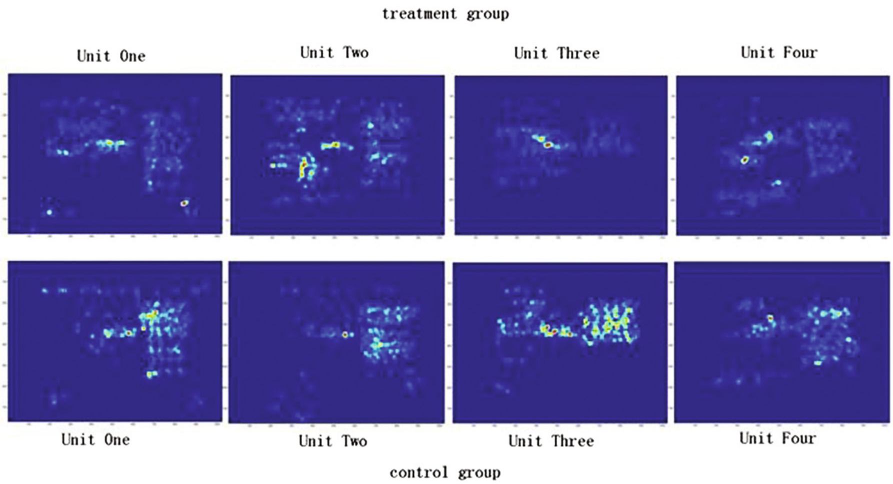

Fig. 2. Heatmaps generated by the treatment and control group after studying the multimedia instruction

In contrast, the distribution of heat spots generated by the control group was heavily skewed to the right (text) side, suggesting learners in control group spent most time studying text content rather than image content. One anomaly is the heatmap for Unit 3, which shows roughly equal distribution of eye fixations on both sides. A possible explanation is that the image content in Unit 3 is a screen capture of a written story. It is essentially text-based, and thus learners simply processed it the same way as the rest of text content in the unit.

The further analysis of learners' eye movement in 5-second segments confirmed the learning pattern revealed by the heatmaps: When there were no visual cues on display, learners would spend most of their time studying text content and only glanced at image content occasionally. However, once visual cues appeared on the screen, they would immediately direct their attention to the cues and cued content. Such difference in learning pattern is clearly shown in Fig. 3: When studying Unit 4, the control group

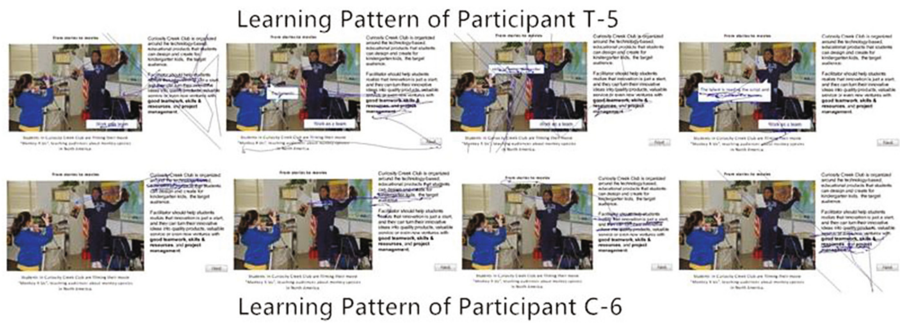

Fig. 3. Participants' learning pattern when studying Unit 4 with and without visual cues

participant (C-6) simply read the text content line by line without paying much attention to the image content, but the treatment group participant (T-5) paid almost equal attention to both text and image, indicated by a good number of eye movement trails between the two types of content.

3.2 Learners' Responses to the Presence of Visual Cues

In order to study how participants responded to the presence of visual cues, this study collected and analyzed eye movement data within one second of the appearance of visual cues. The eye movement trails revealed that the participants responded to most emerging visual cues immediately, discontinuing their current learning activities and casting their attention to the cued content. Visual cues appeared a total of 16 times during the overall online learning process. Among those 16 times, Participant T-1 moved her gaze to visual cues within one second for 14 times. The number is 13 out 16 for Participant T3, 16 out of 16 for Participant T-5, and 14 out of 16 for Participant T-7. The average response rate is 89.1 %. Figure 4 shows such an example, as all four participants in the treatment group responded to a visual cue in a very similar way.

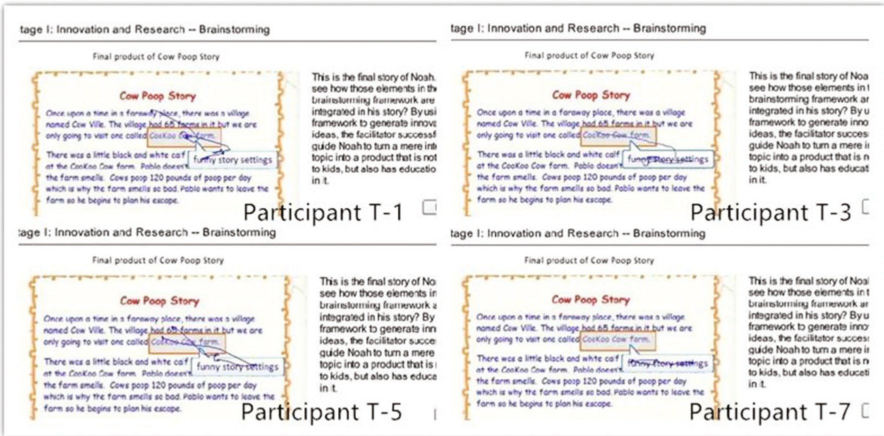

Fig. 4. Treatment group participants' immediate reactions to a visual cue in Unit 3

Moreover, it is found that the initial attention to visual cues sometimes resulted in subsequent higher-order learning behaviors such as information seeking and meaning-making, evidenced in participants' eye movement trails between text and image content, as well as eye fixations on non-cued but relevant graphic information in the multimedia instruction.

For example, Fig. 5 shows the eye fixations and movement trails of Participant T-1 when studying Unit 1. No visual cues were presented in the first 15 s, as a result, the participant's eye fixations mainly clustered on the right side, indicating she was mainly reading the text content. However, such learning pattern was immediately altered upon the appearance of two captions. The captions highlight the available technologies in the classroom (i.e., projector and computer) in order to exemplify a teaching principle that facilitators of enrichment programs should let students know about the technologies and resources available to them at the beginning of the program. We can see the participant immediately paid attention to the emerging captions, and later moved her gaze to another technology equipment in the image − a television on the top corner of the classroom. Such behavior suggests visual cues might prompt her to examine the image content more carefully and try to establish connections between abstract teaching principles and concrete examples.

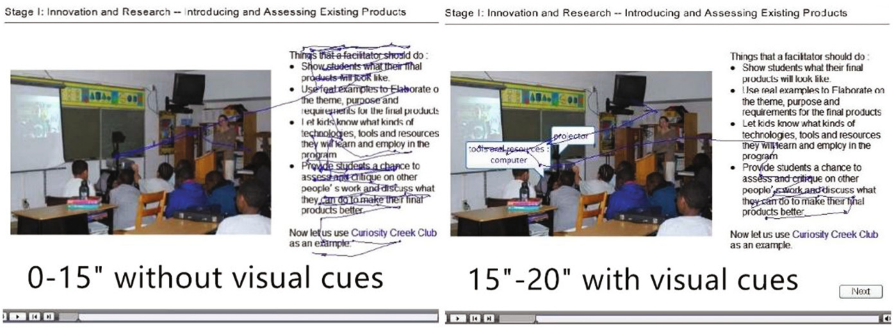

Fig. 5. A learner's eye movement when studying with and without the presence of visual cues

3.3 Effect of Visual Cues on Learning Outcomes

Two questions were raised at the end of the instruction to assess how well participants have memorized the instructional content, which are: (1) "what are the reasons for a facilitator (instructor) to introduce an existing product for students to assess in the beginning?" and (2) "what are the criteria for student product?" The two questions were based on the instructional content in Unit 1 and Unit 2. To answer them correctly, participants need to recall three key points from Unit 1 and three key points from Unit 2.

Participants' responses and correctly answered key points (score) are listed in the following table (Table 2). Since the normal distribution assumption for parametric analysis was not met, Mann-Whitney non-parametric test was conducted in this study to compare the learning outcomes between the treatment and control groups. In general, the treatment group out-performed the control group in terms of knowledge recall: The average key points recalled are 4.0 for treatment group and 1.75 for control group, which are significantly different at 0.1 level ($p = .078$). While there is no significant difference in treatment and control group's performances for Question 1 (Mean = 1.75 and 1.25 respectively, $p = .405$), treatment group recalled significantly more points than control group when answering Question 2 (Mean = 2.25 and 0.5 respectively, $p = .036$).

Table 2. Participants' responses to the two questions and correctly answered key points

No.	Response and scores to Question 1	Response and scores to Question 2
T-1	"students learn facts, students have model" *(1 point)*	"facts, title, explanation" *(1 point)*
T-3	"to give students an impression of the product" *(1 point)*	"it should be based on facts, and it is for younger kids" *(2 point)*
T-5	"introducing available tools, the criteria for their products, brainstorm ideas" *(3 points)*	"it should have facts, appropriate for kindergarten kids, pictures match the story" *(3 points)*
T-7	"showcase end products, demonstrate technologies" (*2 points*)	"factual information, age appropriateness, relevant pictures" (*3 points*)
C-2	"inform students of the final assignments and provide examples" (*1 points*)	"about animals, story or poetry puzzle" (*0 point*)
C-4	"to practice what the criteria are and familiarize students with the grading and expectations" (*1 point)*	"i do not remember" *(0 point*)
C-6	"let students know what they final product will look like, give them a general idea" *(1 point)*	"It is about the animal, should be an interesting story." (*1 point*)
C-8	"know the requirements; what is the final product looks like." *(2 points)*	"story, some facts, environment related, animals" *(1 point)*

4 Discussion and Conclusion

The results of this study provide tentative answers to the three research questions raised earlier in this paper. Based on the empirical evidence from the eye data, we conclude that the presence of visual cues is able to change the pattern of how learners approach the multimedia instruction: Without visual cues, learners tend to study mainly the text content while largely overlook the image content. The use of visual cues within an image has attracted more attention to the image content and seems to prompt learners look for relevant information in both cued and non-cued areas within the image. In other words, visual cues can be a highly effective design feature for multimedia instruction that guides learners to study specific content and engage in higher-order thinking activities such as information-seeking and meaning-making.

Visual cues are also found to be highly effective in attracting online learners' attention. Upon the appearance of a visual cue, most learners would stop their current learning activity immediately and swiftly move their gaze to the cue or cued content (with an average response rate of 89.1 % in this study). This finding is consistent with the existing research in the literature that proved visual cues to be an effective tool for attention-grabbing purposes [9, 10]. However, such swift response to visual cues is not always desirable, since visual cues can then turn out to be a major source of distraction and confusion during online learning process [14, 15]. As a result, it is advisable to design visual cues to be more learner-controlled, allowing them to be triggered and closed by learners.

In addition, the use of visual cues seems to benefit the online learning outcomes by enhancing learners' recall of instructional content. On average, learners who received the multimedia content with visual cues recalled more key points than those without. In fact, when visual cues were not presented, some learners (C-2 and C-4) failed to recall any key points after the study, which highlights the necessity of adding visual cues in instructional design and content development. However, it is important to note that the small participant pool in this study makes it difficult to make any sound statistical inference, and other factors such as the entry-level knowledge of participant or difficulty level of quiz question can also affect how the statistical results should be interpreted in this study.

In conclusion, the effect of visual cues in multimedia instruction has been studied extensively in both the field of education and psychology, endowing us with plenty of empirical evidence regarding its effectiveness and a wide range of theories from cognitive psychology. This study contributes to such scholastic body by using the actual eye data to investigate and compare learners' online learning behaviors with or without visual cues. The findings in this study are contextual in nature due to its small sample size and related research design, therefore one should be very careful to generalize the findings to broader contexts. However, it is our hope that the findings in this study can offer unique insights and perspectives regarding the design and effect of visual cues in multimedia instruction.

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Microlessons in Chinese Universities: Concepts, Technology, and Case Analyses

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Abstract. The objective of this paper is analyze 1,500 microlessons in regard to design, technical features, types, and development problems. The microlessons had all been entered in China's National Multimedia Courseware. Relevant suggestions and strategies are also offered on the use of microlessons in higher education. The relationships among the five key concepts, namely, microlesson, Flipped Classroom, SPOC, MOOCs and Rapid E-learning, are described. This paper then proposed a Five-in-one Relation Model and Four Stage Model of Microlesson Evolution. Microlessons are categorized, based on their technical complexity, captioning, language fluency, video clarity, teaching skill, overall video effects and comprehensiveness. Instructional design, technical realization, and presentation effect are considered. In this paper, two microlesson cases are analyzed. The problems related to microlesson development are summarized, and proposals are made for improvement measures.

Keywords: Microlesson · Flipped classroom · Rapid e-learning · Moocs · SPOC

1 Introduction

There are many new concepts, terms, and ideas in the field of educational technology. These seem to come up suddenly and they can be bewildering; however, they share many common characteristics. E-learning, blended learning and Rapid e-learning were popular a few years ago, whereas Flipped classroom, Microlesson, Generally, authors are asked to define abbreviations the first time they are used. Something like "small private online courses (SPOCs) and massive open online courses (MOOCs) are more common now. Regardless of when they were popular, all of these models have similar theoretical foundations, origins, development paths and even common technical characteristics. Rome is not built in a day. Their origin and development of these models is necessary for understanding their mutual relations [3].

More and more teachers are investing significant amounts of time designing many kinds of microlessons for their teaching. Most of these teachers do not realize the mutual relationships among Microlesson, Flipped classroom and MOOCs. Furthermore, many teachers also do not know much about either the technology of microlessons or the methods of microlesson development. For example, some teachers still cannot distinguish Micro-video, Micro-lecture, and Micro-course from Microlesson. According to their thinking, all courseware with playing time of 8–10 min is

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Microlesson. Undoubtedly, such misunderstandings lead to many serious problems in the use of information and communication technology in college classrooms.

Because of this situation, this paper will focus on three questions: (i) What are the relationships among the above-mentioned terms (i.e., Microlesson, Flipped classroom and MOOCs? (ii) What is a good microlesson?; and (iii) How can a good microlesson be designed? Quantitative study and case study methods are adopted in this paper to achieve these research targets.

2 Literature Review

The development of information and communication technology in education during the past decade can be divided into three stages involving five core concepts: Rapid e-learning, Microlesson, Flipped Classroom, SPOC, and MOOC. Mutual relationships among these concepts have built up the basic framework for the development of online education [3]. The first stage is represented by E-learning and Open Courseware, including Rapid e-learning technology. The second stage is represented by Flipped Classroom and Microlesson. The third stage is typically represented by SPOC and MOOC. Those concepts constitute the basic factors of education informatization in recent years.

Rapid e-learning is key to the development of educational technology. Rapid e-learning is an electronic courseware development scheme which quickly designs and produces digital teaching resources using a template suite. Rapid e-learning helps teachers to efficiently design and produce various types of courseware (e.g., slides, audio, video or other forms of digital resources). After testing and integration, the teaching courseware can be published on teaching websites [6]. The traditional courseware development mode takes several months to produce courseware. In contrast, Rapid e-learning technology can reduce the production time to several weeks [2].

Flipped classroom is a teaching mode and instructional strategy which is based on Blended learning. Flipped classroom reverses traditional face-to-face education by delivering instructional content, often online, outside of the classroom [1]. Students watch online lectures before class, collaborate in online discussions, carry out research at home and discuss concepts in the classroom with the guidance of the instructor. Flipped classroom is a new instruction model which combines face-to-face classroom interaction with online learning. The core idea is to emphasize student initiative in the learning process, so that the students become the subject of the learning process. The basic implementation process of flipped classroom is as follows. The instructor produces a microlesson and publishes it online. Students preview the microlesson before class. In the classroom, the students discuss the microlesson, engage in learning activities and do homework. The instructor is also available to answer questions after class. Microlesson, which originated from Microlecture, refers to approximately 60 s presentations with a specific structure or topic. Microlesson is also called “One-minute lecture” [7]. The meaning and application mode of Microlesson has changed with application [9]. Specific lectures are combined with specific activities designed to promote the epistemic engagement of the learner. The lectures are finished in 3 to 10 min [9].

In China, Tiesheng Hu [10] proposed that Microlesson is an organic combination of teaching resources and practices which uses video as the main carrier of information, which reflects teachers' teaching and learning activities for certain teaching process during the class-teaching. Professor Jiahou Li [5] thinks that "Microlesson" and "Microcourse" are synonymous. Both terms refer to a short course of less than ten minutes, with a specific teaching goal, limited content, and a specific focus on one question. Professor Zhiting Zhu [11] believes that Microcourse is a precisely designed lecture with a specific teaching subject. Microcourse is adapted to the fast pace of modern times and it is suitable for mobile learning, ubiquitous learning and fragmented learning. Microcourse is also a new course form with excellent lessons and small capacity that is completed within ten minutes.

Based on the views of Tiesheng Hu [10], Zhao [3] divided the development process of Microlessons into four stages and proposed the "Four Stages in the Evolution of the Microlesson Model" (see Fig. 1).

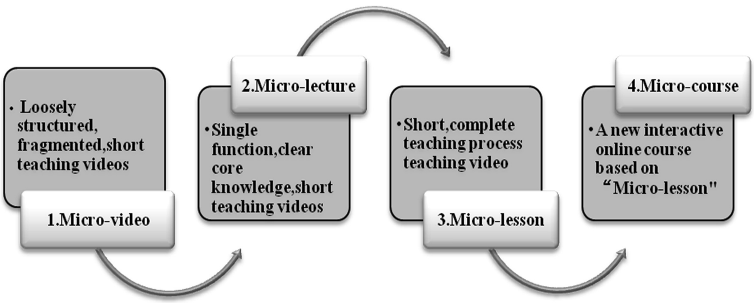

Fig. 1. Four stages in the evolution of the microlesson model

A SPOC is another version of an MOOC. MOOCs are massive and may be simultaneously taught to thousands or tens of thousands of students. In contrast, SPOCs have some restrictive requirements. For example, only students who meet the course requirements are allowed to enroll. The course content includes video lectures, assessments with immediate feedback, interactive labs and discussion forums [4]. Unlike MOOCs and Flipped classroom, SPOCs have limited enrollment and are often used as part of a course for credit. Students typically access interactive content at their own pace. Studies have shown that this teaching model can improve academic performance [8].

Technically, MOOCs focus mainly on short video clips of class lectures. The MOOCs are similar to the free, short teaching videos designed by the famous Khan Academy, actually which is above-mentioned "Microlesson". Microlesson can have various kinds of interactive functions to test how much content the students have understood. Examples of these functions include (i) online quizzes and (ii) letting students write a program code and give feedback automatically. Course assistants may view and manage the online forums. There will also be assignments and tests for some courses.

The internal relationships among different periods of education informatization during the past 10 years can be summarized in this way: The technical support of Rapid e-learning together with the four core applications of Microlesson, flipped classroom, SPOC and MOOC form the "Five-in-one" model, which establishes the basic framework of information and communication technology in education.

3 Data Collection

In order to learn more about the current status of Microlesson in higher education in China, more than 1500 microlessons were analyzed to determine their design types and technical features. The microlessons had been entered in the National Multimedia Courseware Contest (NMCC)[1].

3.1 Background Information

Exactly 1511 microlessons were involved in this research. These microlessons were from three categories of institutions that participated in NMCC: undergraduate institutes, vocational colleges, and vocational schools[2] (Fig. 2).

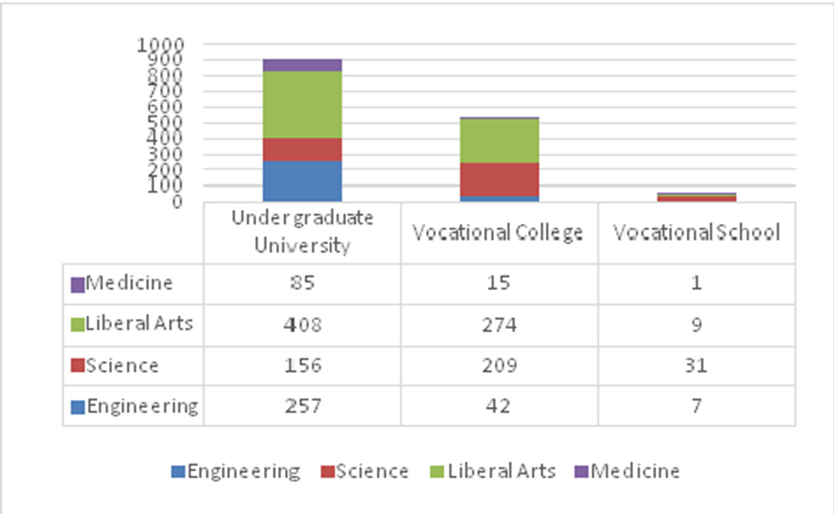

Fig. 2. Backgrounds of the microlesson in NMCC (Color figure online)

[1] NMCC is one of the most famous national courseware contests hosted by Ministry of Education in China. It has been hosted for 15 years. Micro-lesson is one section of the project.

[2] Few microlessons were submitted by vocational schools. Therefore, they are negligible in the subsequent statistics.

3.2 Category, Type, and Technique

The microlessons were divided into five categories and ten types according to development technique and expression (Table 1).

Table 1. Different Types of Microlessons

Category	Type
Classroom Video	Classroom Lecture (CL)
	Lecture with Slide-snap (LS)
Custom Video	Screen Capture (SC)
	Software Simulation (SS)
	Automatic Record (AR)
Field Video	Role Play (RP)
	Live Demo (LD)
Animation Video	Animated Cartoon (AC)
	Whiteboard Animation (WA)
Post-editing Video	Virtual Scenes (VS)

3.3 Assessment Indicator

The microlessons were categorized and ranked according to the contest guidelines. A detailed assessment system was developed to analyze three dimensions and nine elements of the microlessons.

- From the perspective of instruction design, assessments were made of (i) the topic and content of the microlessons (e.g., concrete knowledge and focused content); (ii) the presentation skill of the instructors (e.g., natural, friendly, and attractive), and (iii) the completeness of the teaching process (introduction, teaching, exercise, and summary).
- From the perspective of technological achievement, assessments were made of (i) the audio level, (ii) captions, and (iii) animation.
- From the perspective of presentation effect, assessments were made of (i) the clarity of audio and video, (ii) language fluency and (iii) the vividness of the presenting form.

4 Data Analysis

4.1 Types of Microlessons

Analysis showed that Screen Capture (SC) and the Lecture with Slide-snap (LS) were the top two types of microlessons, accounting for 32 and 22 % of the total number of microlessons, respectively. Classroom Lecture (CL) and Live Demo (LD) accounted for 4 and 10 % of the total, respectively. Slightly more than two-thirds (68 %) of the microlessons were one of these four types. Obviously, this indicates that most microlessons are still developed using traditional methods, especially Excellent Courses. In other words, classroom video is still the most commonly adopted method of Microlesson design in colleges. However, this development style has been shown to have very poor effect in the past ten years. The analysis also indicated that it is difficult for these four types of microlesson to attain high scores in the contest (Fig. 3).

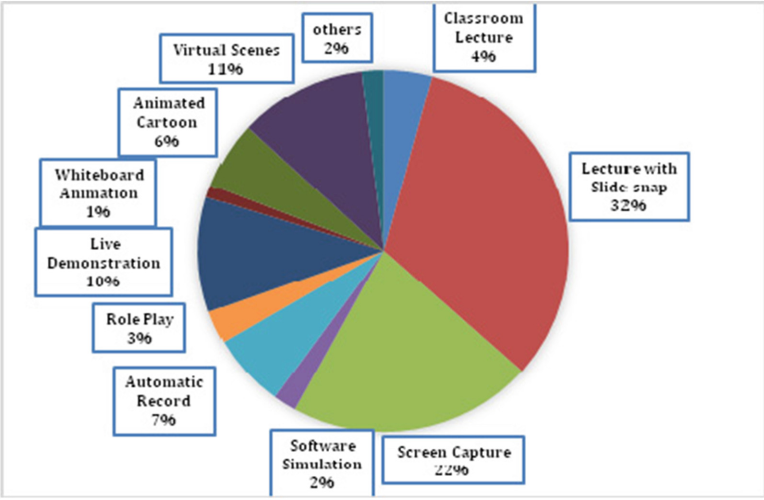

Fig. 3. The proportion of different types of microlessons (Color figure online)

The study also indicated that Virtual Scenes (VS) and Animated Cartoon (AC) made up 11 and 6 % of the total, respectively. These two types of microlessons generally attain high scores because of their exquisite and interesting effects. However, these two types of microlessons need the support of professional engineers during development, leading to high costs and greater investment of time. Teachers also need more training to master information and communication technology skills.

4.2 Level of Development Technique

Result shows that 186 microlessons had "high level of development technique" (complex). This accounted for only 12.3 % of the total. In comparison, 703 microlessons had "low level" (simple). This represented 41.0 % of the total. Undoubtedly, these results indicate that most colleges do not make full use of various new techniques in microlesson development.

Microlesson is a new teaching model in the Web 3.0 era. Learners and learning styles have both changed significantly with time. Because of the development of social media and the changes that Internet culture has brought to online learning styles, teachers and microlesson producers must adapt to the open-minded, virtual, interactive, and autonomous features of Internet culture. Therefore, keying video, virtual scenes, animation, and other new technologies should be fully utilized in the production of microlessons to attract the new Internet generation. This is the key to the success of the new teaching model.

4.3 Video Definition

In the era of HDTV, everybody likes to watch high-definition video, and nobody likes to watch low definition videos. It is the same in online learning. Overall, the image definition of most microlessons met the requirements of online learning. The data showed that 488 videos had high definition. This was 32.3 % of all microlessons. The number of videos with normal definition was 759 (50.2 % of the total). There were 261 microlessons with low definition (17.3 % of the total). Most of the microlessons with low definition were classroom videos. These videos were often characterized by dim picture, low lighting, and noisy surroundings.

Obviously, video definition is an important factor that determines whether students are willing to watch the microlesson. Teachers need to focus on the filming environment (e.g., clean background, brightness, and sound clarity). Green screen video is a common technical solution when making microlessons. By combining lecture video with a slideshow, this technology can provide video with good definition and clean background. Green screen video has been proven to be a highly efficient solution for teachers, allowing them to develop microlessons after simple training.

4.4 Smoothness of Presentation

Generally, most teachers demonstrate good presentation skills in front of the camera lens. The actions and expressions of these teachers are natural, fluent, and dramatic. However, not every teacher can do this in microlessons.

The results indicated that 622 teachers gave a smooth presentation in the microlessons. This accounted for 41.2 % of the total. Only 104 teachers did not give a smooth performance. More than half (799) of the teachers gave a smooth presentation during teaching.

It should be noted that a small portion of teachers lack necessary skills while facing the lens. These teachers often have rigid movements. Sometimes they are quite boring. The suggestion for these teachers is to keep on developing their performance skill to improve their presentation skill in front of the camera. This is the basic requirement for teachers in network times. It is also vital to the professional development of the teachers.

4.5 Coherency of the Teaching Process

Coherency (i.e., overall structure) is an important indicator of the quality of microlesson design. Our analysis indicated that the design of the teaching structure was incomplete in most microlessons. The lecture received the most attention in the majority of microlessons. Other aspects of microlessons (e.g., exercise, quizzes, feedback and navigation) were generally ignored.

The data showed that the teaching structure was incomplete in 475 microlessons. It was also observed that 766 microlessons (82.1 %) have only parts of the process. There were 475 microlessons with complete structure. These accounted for only 17.3 % of the total.

Certainly, microlessons are usually shorter than traditional classroom lessons. However, this does not mean that parts of the teaching process can be deleted. This could have serious results. Teaching effectiveness will be greatly reduced if interaction, exercises, feedback, and communication are omitted, whether in the classroom or online.

5 Case Studies

The following two cases are typical. They are introduced according to topic selection, instruction design, technology, and the teacher's presentation skill.

5.1 Case One

Technologically, the first microlesson was a typical keying-video presentation, which used various techniques such as Green-screen Video Keying, Post-editing Background Animation, and Movie Clips Snap. It adopted a "TV Presenter" structure with dynamic subtitles to present a clear and concise picture. Movie Clips Snap was also used in selecting materials, so the microlesson has substantial content and a wonderful picture. As to the teaching performance, the teacher was telegenic and used nature gestures. Based on these statements, the microlesson won first prize in the liberal arts session.

This microlesson used a simple animation effect at the beginning. The concise and clear animation was consistent with the visual style of the remaining content. The video footage and speech perceptibility also had high standard, providing excellent visual appeal.

The lecture video was shot in front of a green screen in a studio. The video was converted to alpha channel by keying and then synchronized with slides. The action script was designed before shooting which made it easy to coordinate the teacher's actions with the background content. The learners could watch the video with subtitles in English or Chinese.

As for material, this microlesson used many movie clips. This not only stimulated student interest in learning, but also saved production costs. Additionally, at the end of the microlesson, the teacher recommended extra reading materials and assignments for students. This improved the completeness of the teaching process. Students could continue to read after completing the online lesson.

In conclusion, this microlesson was successful because it balanced and coordinated various aspects including topic, instructional design, video effect, and presentation skill.

5.2 Case Two

This microlesson had a low score and was therefore a failure. The microlesson exposes some typical problems in microlesson design. These problems include inappropriate topic, fragmentary design, unsuitable technical solution, and rigid performance.

Firstly, the topic was too large to present in a 10-minute microlesson. The microlesson consisted primarily of teaching video clips that were shot in the classroom. The teacher presented three knowledge points rather than one. The microlesson would probably be better if the contents were divided into three parts and then presented in order.

Secondly, the production technique was coarse and the visual appearance was poor. The microlesson was developed using the pattern of traditional excellent courses, which is created by synchronizing live video and slides. New technology such as animation and whiteboard video could improve the visual effects, creating an easy and fun online for learners.

Thirdly, the microlesson was deficient because the teaching structure lacked certain vital segments. As in most microlessons, the teaching process was incomplete. The lecture ended without exercises or quizzes. Microlessons are designed for online self-learning; therefore, quizzes are often necessary for learning. Otherwise the students cannot judge whether or not they truly understand the lesson.

Furthermore, the presentation skill needed substantial improvement. The teacher spoke with a significant accent (dialect) which made it difficult for the students to understand. Considering the learners would expand with the development from microlesson and MOOCs, which are more evident about the standard of teaching language.

Many measures could be adopted to improve the work. For example, to overcome nervousness, the teacher needs more practice to improve his/her teaching skills in front of the camera. Teachers who have trouble with Mandarin Chinese should consider using TTS software and animation assistant.

6 Conclusion

The evaluation and case analyses indicated that Microlesson has become an important part of educational reform in Chinese universities and colleges. Teachers have spent significant amounts of time in developing microlessons and some of their achievements are impressive. The evaluation showed that there are various types of microlessons. Most of the microlessons are quite good in language fluency, video resolution, and presentation smoothness. However, there are also some common problems that are of concern. These problems include the use of a single technical form, poor visual effects, and incomplete teaching sections.

The evaluation showed several problems in microlesson design. First, there are still misunderstandings about the concept of Microlesson. The essential characteristics of Microlesson are not fully understood. The most common phenomenon is that the length of microlesson is over emphasized, whereas other features of microlessons are ignored. During the design process, some designers are not aware that Microlesson is essentially a type of digital courseware which aims to provide students with individual, independent, high quality, and efficient digital learning resources. Microlessons are not cut smiley and not just concentrated on the traditional teaching content but deliverer knowledge from the classroom to the Internet. The essence of Microlesson is that it is a structured and miniature online courseware, which is designed based on core knowledge of a subject, with short teaching video and a clear teaching process.

Second, many microlessons lack systematic instructional design and fail to consider important aspects such as topic, structural design, application strategy, implementation, and feedback. Teaching design is the basis for ensuring the effectiveness of microlessons. If some sections are omitted, students will not understand the lesson completely and they will fail to acquire the knowledge fully. This will influence the effectiveness of Flipped Classroom and MOOCs.

Third, many microlessons are still fixed on traditional teaching ideas and lack the learner-centered design concept. Microlessons are short; therefore, the design of teaching strategies and the arrangement of teaching content should be based on applicability, ease of use and attractiveness to learners. Microlessons should not be designed for the convenience of the teachers. For example, the characteristics and needs of the students should be considered when making choices about subtitles, video clarity, and voice quality during the production of microlessons.

Fourth, many microlessons still the simulation of the excellent courses. Furthermore, video shooting and visual effects need to be improved. The evaluation showed that some microlessons are simply segments that have been clipped from recordings of high quality on-line courses. Although this method is simple and inexpensive, the video image is rough and there is background noise. This makes it difficult to attract on-line learners.

Finally, regarding the technical development of microlessons, the majority of production staff are technicians who still use the traditional audio-visual model. Relatively few teachers lead production teams or develop microlessons on their own. Practice has shown that this development model is disadvantageous because it fails to fully implement teaching ideas and features in the production of microlessons. This results in dull and monotonous microlessons which lack personal features. The gradually maturing technology of Rapid e-learning makes it more convenient for teachers to develop microlessons independently. It is easy for teachers to master the necessary skills through simple training. This is an inevitable trend in the development of international educational informatization.

There are several possible responses to the above results. First, the appropriateness of the topic for a microlesson should be emphasized. Practice has shown that the teaching content that requires on-site teaching, practice, or one-to-one correction is not suitable for microlesson. This type of content requires strong interaction between teachers and students. It is difficult to achieve this technically in Microlesson. Appropriate microlesson topics are those which are short and without too much detail. Microlessons are usually less than 10 min long. Too much content will lead to confusion between major and minor content and to incomplete understanding of the content. The content should focus on the key point and the difficult points. Avoid striving for grandiose knowledge. In addition, the integrity and completeness of the structure and sections should be noted. The principles of traditional teaching design are also applicable to Microlesson. Having a clear teaching objective and a focus on coherency are also the basic principles for microlesson design. These principles cannot be ignored.

Additionally, it is important to adapt to the development of new technology. Rapid e-learning is an example of one new technology that can be applied to microlesson design. Such technology not only reduces production costs but also allows teachers to participate in the development process. The main problem of online learning is how to stimulate and maintain student interest and motivation during the online self-learning process. With improvement of teaching techniques, various animated features, video keying, and virtual scenes are easy to use. Making full of use of these techniques is important for enhancing the visual appeal of microlessons and for stimulating student interest.

7 Discussion

To accurately and fully recognize Microlesson, we must go beyond the technological point of view and consider the whole background of educational informatization. The use of information and communication technology use in education during recent decades has shown that teaching technology can only be put into practice when full consideration is given to guiding ideology, application model, technical solution and faculty development. The use of Microlesson to drive teaching reform in colleges and universities can only be realized after considering all of these factors.

First, the basis for implementing the above ideas is to consider and understand the “Five-in-One” model which includes Microlesson, Rapid e-learning, Flipped Classroom, SPOC and MOOCs. As a technological tool, Rapid e-learning provides support for the design and production of microlessons. The two teaching patterns, Flipped Classroom and SPOC provide an important framework design for the application of Microlesson. Furthermore, MOOCs provide direction and a goal for the future development of Microlesson. Five-in-One model can help teachers (i) adapt to the new needs of teaching in this time of information and communication technology, (ii) use the Internet to extend their academic and social influence, and (iii) achieve the goal of professional development.

Second, understanding the core concept of Microlesson is essential for designing and producing high-level projects. The core of Microlesson is “Lesson” rather than “Micro”. Because the core is “Lesson”, it should be expressed as a multi-dimensional interaction with several necessary sections between teachers and students and with the premise of following learner’s cognitive features. Among them, teaching components, interaction and feedback are important factors. From the perspective of teaching theory, preparation, lecture, practice, and feedback are basic components which cannot be ignored in Microlesson. Therefore, no matter whether the microlesson is five minutes or fifteen, these sections should be included in the design of the teaching project. Otherwise, it will be Micro-video rather than Microlesson.

Third, it is important to emphasize the need for teaching skills (e.g., fluent expression, good body language, and good presentation skill) when planning and designing microlessons. The ability to remain composed in front of the camera is an important skill for teachers in this age of widespread video use. Young teachers should realize that the development of this skill is not only an unavoidable challenge in their professional career, but also an opportunity in the new technological environment.

Once this skill is properly grasped, the professional development of teachers will be promoted.

Ultimately, the factor of technical support is necessary for microlesson design. However, this does not mean the teacher's burden will increase. The development and maturation of rapid e-learning technology provides an important technical basis for teachers to devote to teaching informatization. Software and other Rapid e-learning tools (which consist of all kinds of simple operation methods and powerful templates and suites) make it possible for teachers to rapidly grasp the process microlesson development after a short training period. In this way, Microlesson may open a new stage of teaching informatization which integrates content experts (subject teacher) and technology experts (audio-visual engineer).

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Designing Effective Materials and Activities for Mobile Augmented Learning

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Abstract. This paper presents the findings from a study of augmented mobile learning with Chinese students (n = 37) at a post-secondary vocational school. Students were enrolled in a course concerning horticultural science and applications. We augmented the school's botanical garden with supplemental information, accessed by students scanning QR codes that were affixed near 20 distinct plant species. This paper presents a design study that investigates what factors are important to the development of effective augmented mobile curriculum activities. Working closely with the course instructor, we developed three challenging activities concerned with horticultural applications that required students to utilize the augmented information. The paper presents our designs of the problems and the augmented materials, as well as an analysis of student interactions with materials and questionnaire data about student collaborations during problem solving. We conclude with findings about the factors influencing effective design of such activities.

Keywords: Ubiquitous learning · Augmented reality · Mobile learning · Science education

1 Introduction

With the rapid development of mobile and wireless communication technologies, mobile learning has emerged as an interesting topic of research within the CSCL community [1, 2]. Mobile learners can use both physical and digital resources in classrooms, online, or anywhere in their environment using mobile devices, wireless networks, and educational software applications. Much of the current research has focused on K12 and higher education, demonstrating that mobile devices can support collaborative learning activities both in and outside of classrooms [3–7].

One interesting approach to mobile learning is to augment students' physical environment with supplemental information that can be gained through their mobile devices. Spikol et al. [8] investigated students' use of mobile phones to scan information about their surrounding environment, but focused more on students' scientific practices than on their use of augmented materials for conceptual learning. Others have studied such augmentations, including [9], whose project called "the ambient wood" engaged students in exploring the hidden aspects of trees and other plants, including sounds and invisible features (i.e., in the roots or inside the trees). Still, there remains a

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need for studies that advance our understanding, in CSCL, of how to design such augmentation activities such that they directly serve purposes of learning and collaboration. A recent efforts called the EcoMobile project [10] has taken major strides toward sophisticated interactions and materials, demonstrating content and affective learning gains, but is still focused on supporting specific forms of scientific inquiry, such as the combination of Augmented Reality (AR) and environmental probes.

This study seeks to contribute a new design of augmented mobile learning that emphasizes the structured design of materials and activities, in order to understand what factors may be important to creating effective learning conditions. It is clearly an attractive approach, and compelling for students. But what kinds of activities will result in good learning of the targeted conceptual material? What kinds of content should be embedded in the environment, and how should students be expected to utilize that information? We approach this challenge through a design oriented methodology, designing materials and activities to produce an effective augmented mobile learning activity, and then analyzing the factors that underlie the efficacy of our designs.

Our research is in the context of vocational education, which is an important challenge in China, where we seek to infuse practitioners of various disciplines with both practical and theoretical knowledge. Students often find it difficult to apply conceptual content in service to practical problems, and the vocational education setting provides a suitable opportunity to study how students can make such connections. We collaborated with a teacher of gardening and horticulture to augment the school's botanical garden – which typically serves an instructional role – with supplemental information that would be necessary for students in order to solve a set of challenging problems. The augmented materials were accessed by students through scanning QR codes that were affixed near 37 distinct plant species. This paper presents our designs of materials and activities that helped students successfully solve the challenging problems, and develop conceptual understandings. We present our designs of the problems and the augmented materials, as well as an analysis of student interactions with materials and summaries of student collaborations during problem solving.

2 Methods

This design-oriented study engaged post-secondary vocational students in a mobile augmented learning task, where they utilized tablet computers to gain supplementary material in support of challenging tasks about plant horticulture. This school maintains a substantial garden infrastructure that was used as a basis for questions about plant health, plant choices for interior design, and plant ecological features.

2.1 Participants

Participants were 37 students and one teacher from a post-secondary vocational school located in eastern China. The students were from 2 different majors (garden technology, biological technology and application), and in either their first or second year of a three year program. The teacher was a veteran of eighteen years' experience.

2.2 Study Design

This is a design-oriented study, aiming to reveal effective design elements and factors in a mobile augmented learning curriculum. Students were asked to complete three challenging problems over three one-hour sessions (1 per week), and could work on the problems in any sequence, individually or collaboratively.

Materials. Materials were designed in close collaboration with the teacher, such that the tablet content was essential for solving the tasks. 20 plants were chosen for augmentation, based on a distribution across important horticultural variables, including: Physical features (leafs, stalks, flowers), ecological features, and gardening applications. Many plants were available, but the teacher helped to choose a wide representation. Students did not need to survey the augmented information about all plants in order to solve the problems, but the exact number they should survey was not specified (i.e., was left open). For each plant, a QR "fiducial" code was developed, and printed on to a small card that was affixed in front of the plant. Augmentation topics included: (1) name and geographical regions, (2) shape and physical features, (3) living environment, (4) ecological features, (5) gardening applications, (6) life cycle and reproduction, (7) cultivation techniques, (8) disease and pest control.

Augmented resources: Using the 8 categories above, a Web page was developed with augmented information about the plant. These pages were stored and retrieved in a special content management system called The Learning Cell [11, 12]. Students' access of these pages could be easily monitored and traced by the Learning Cell system, allowing for analysis of access patterns, including social network information.

Problems: Three problems were designed to challenge students in using the augmented information. In the first problem, students were asked to learn plant shape characteristics, judge plants level of health using physical attributes, and explain their reasons in detail. The second problem required them to study plants' ornamental value and determine those that are not suitable for interior design. The third problem was concerned with the ecological features of plants, placing plant names in appropriate cells of a table.

Student tablets: The students were provided with NEC Android tablets, with a custom application that launched a learning cell Web page when the relevant QR code was scanned.

Procedure. Students were oriented to the task during the first week of class, instructed by their teacher that it was a hands-on digital assignment where they would be asked to reflect about plants in the local school garden and solve problems. They were told that it was an open task, and that they would need information that was available by scanning the QR codes that they would find scattered around the gardens. While they did not need to scan all plants in order to complete the tasks, they often needed to scan some plants more than once, because the augmented information was substantive (Figs. 1, 2 and 3).

Fig. 1. Plants with QR codes

Fig. 2. Students scanning

Fig. 3. Students collaborating on task

2.3 Data Sources

Which plants were surveyed?

The Learning Cell Platform captured each time a plant was surveyed by any students. This could allow for an analysis of which students surveyed the same plant, and how many plants were surveyed.

Successful completion of problems.

A pre-post test designed by the classroom teacher. This could allow for an analysis of the effect of students' conceptual learning. In addition, after each session, every student summits their finding paper. The teacher corrected their finding, so we captured which problems were completed by students, and in what sequence.

Level of collaboration.

We observed the patterns of collaboration amongst students, and also administered a structured questionnaire to measure their preference for collaboration and experience of the task (Cronbach's Alpha = .845).

3 Results

According to the data from Learning Cell Platform, we found all the 20 plants were surveyed at some point by at least one student, but none of students surveyed all the 20 plants, and none of plants was surveyed by all the students. The average number of times that each plant was surveyed was 35.45, and the average number of students who surveyed each plant was 23.35. These data reveal that students often re-surveyed plants, which typically happened in different sessions. The average number of plants surveyed per student decreased across sessions from 7.82 (session 1), to 5.84 (session 2), to 5.0 (session 3) (Fig. 4).

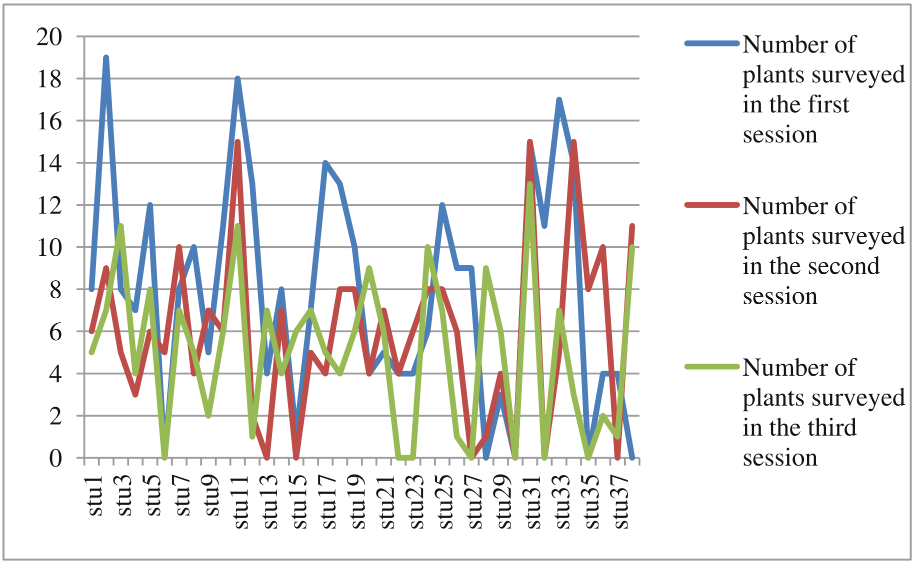

Fig. 4. The number of plants surveyed in three sessions (Color figure online)

From the students' performance on, we found that most students did well on all three problems, finding correct responses to items, and offering detailed explanations. Students differed in terms of which problems they undertook in each session. The teacher was very satisfied with performance on the problems, and students generally demonstrated quite conceptual learning gains. Table 1 shows the t-test results of the pre-test and post-test. The average pre-test score was 34.49, and average post-test score was 61.73. The result ($t = -12.13$, $p = 0.000 < 0.001$) was significant, which indicated that the students had significantly better achievement after the curriculum.

Table 1. Descriptive data and *t*-test results of pre-test and post-test

	N	Mean	S.D.	*t*
Pre-test	37	34.49	11.17	-12.13^{***}
Post-test	37	61.73	8.95	

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

Students worked in a variety of interaction modes, sometimes working individually, and sometimes collaboratively. 14 students conducted the problems in the sequence "1, 2, 3" whereas 16 students did so in the sequence "2, 3, 1" and 8 students in the sequence "3, 2, 1". We surveyed students with a questionnaire about their collaboration experience, with all scores on a scale of 1 (low) to 5 (high). 35 of 37 participants returned the questionnaire, revealing that most students found the task to be interesting (4.17), and did not find the problems to be difficult (2.26). Most students always worked collaboratively with others in the m-learning task (4.20). They preferred to collaborate with others, more so in the mobile task (3.91) than in traditional classroom tasks (3.66). Interestingly, they felt that they could help others to understand during the mobile task (3.63), but did not feel that others could help them to understand (2.77). They agreed that collaborating with other students was important during do the three problems, and thought their performance on the task improved (4.29) and that they learned more (4.34) because of collaborations with peers. Also, the learning task was more interesting (4.37) and they met more friends (4.20) due to collaborations. And they worked with others on tasks which they had already completed, but others had not yet completed (3.97) (Table 2).

Table 2. Descriptive statistics of the questionnaires

Items	**N**	**Mean**	**S. D.**
Q1	35	4.17	.954
Q2	35	2.26	.741
Q3	35	4.20	.677
Q4	35	3.66	1.027
Q5	35	3.91	.853
Q6	35	3.63	.731
Q7	35	2.77	1.003
Q8	35	4.00	.767
Q9	35	3.89	.832
Q10	35	3.91	.781
Q11	35	3.14	.845
Q12	35	3.69	.676
Q13	35	4.29	.667
Q14	35	4.34	.539
Q15	35	4.37	.547
Q16	35	4.20	.677
Q17	35	3.97	.747

From the open questions we found all the students said collaboration was very important for their learning. Because collaboration made them learn more, and can improve the efficiency of learning, the ability of communication and coordination, improve the learning enthusiasm and initiative. Students also responded that they tended to work in groups of 3–4 persons, and that there were two types of collaboration. In the first type, all group members focused on the same problem within the session. This kind of collaboration took three different forms: In one form, different members of the group would each learn a few plants, and then convene to share their learning and complete the problem; In the second form, all the group members discussed and learned the same plants together, and then to finished the problem; in the third form, each group member learned and completed the problem by him or herself, and then shared with other group members at the end. The second type of collaboration is where different people in the group focused on different problems within a session, and then helped each other in the problems they had completed. Approximately half of all students maintained stable collaborative groups across the three sessions, where the other students would find different collaborators as needed. Also, approximately half of students said that they would discuss the problems with others after class, where the other half would not.

There are some problems with collaboration. First, collaborative learning will lead to some students become lazy, who just copy others without thinking and learning. Second, coordination arrangement is not reasonable because of the lack of organization and sometimes a lot of time was waste. Third, there are always several divergences. Forth, reduce active, independent and comprehensive thinking.

4 Conclusions and Implications

The aim of this study was to develop a successful mobile augmented learning activity, and then examine the factors that were important to the design of materials and activities. One important aspect of our method was that of co-design. Because we worked closely with the classroom teacher, who was vigilant about the content of all materials, and the need for students to learn, this helped to ensure that any design would meet the goal of effective content coverage. Here, we articulate three factors that were important to our successful design.

First, all learning activities must make clear connections to learning goals, such that there performance would result in assessable outcomes concerning those goals. In our study, we designed three problems that would require students to know about the plant physical features, ecological features, and gardening applications. These problems were interdependent, such that all three would need to be completed, resulting in coherent understanding of conceptual topics.

Second, learning activities must be challenging and engaging, and must require the augmented information for students to succeed. We developed a clear framework of information that would be needed to solve our problems, and indeed developed the problems with explicit reference to that framework.

Third, clear, explicit connections must be made between augmented materials and the learning activities. In our study, there were 8 conceptual dimensions articulated for each plant, and we ensured that all of these dimensions would be required by the developed problems.

This study provides one successful illustration of a simple design for mobile augmented learning, and tries to articulate several factors or principles that can guide the design of future activities and materials. In our future effort, we hope to develop technology scaffolds that can support student collaborations, and leverage social information relating to patterns of access of the materials.

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Virtual Reality Enabled Training for Social Adaptation in Inclusive Education Settings for School-Aged Children with Autism Spectrum Disorder (ASD)

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Abstract. The transition from kindergarten to primary school tends to be challenging for children with special needs. These children may benefit from relevant training in advance or in addition to school, yet it is challenging to support such training in an authentic, safe and controllable environment. In this paper, we present a Virtual Reality (VR) enabled system to facilitate social adaptation training for school-aged children with clinical or suspected diagnosis of Autism Spectrum Disorders (ASD) in the inclusive education setting. Six unique VR training scenarios with corresponding training protocols are designed, implemented and being delivered to over 100 school-aged children with normal-ranged IQ (IQ > 70) via a 4-side fully immersive CAVE™ VR installation in 28 sessions (14 weeks). Preliminary results indicate that after training completion, children show significant improvements in three major designated aspects, including emotion recognition, affective expression and social reciprocity.

Keywords: Virtual reality · Inclusive education · Social adaptation · Autism Spectrum Disorders

1 Introduction

Children with Autism Spectrum Disorder (ASD) [1] usually exhibit certain social communication deficits in various ways, including difficulties in verbal and non-verbal communication, deficits in social-emotional reciprocity, inability in interpreting facial expressions correctly, difficulties in self-emotion control, etc. Statistical evidences also show that ASD commonly co-occurs with other mental health issues, such as anxiety disorders [2], Attention-Deficit Hyperactivity Disorder (ADHD) [3], etc. These

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characteristics of children with ASD, especially school-aged children, significantly affect their learning in the inclusive education setting of Hong Kong.

Virtual Reality (VR) has been considered as a promising tool to help children with ASD. The early adoption of Virtual Reality Environment (VRE) for psycho-educational training of children with ASD can be traced all the way back to the 90s [4]. The training and learning environment for children with ASD usually needs to be authentic, safe, controllable and manipulable [5], in order to meet the special learning needs of children with ASD. Virtual Reality Learning Environment (VRLE), a VRE with explicit educational objectives and pedagogical design, well meets the requirements of being used as the training and learning environment for children with ASD. With the advent and lowering costs of VR technologies in recent years, it is becoming possible to provide training and learning activities via VR to the mass population for education in general [6] and those with ASD [7].

In this paper, we present a VR-enabled system to facilitate social adaptation training for school-aged children with clinical diagnosis or suspected diagnosis of Autism Spectrum Disorders (ASD) in the inclusive education setting of Hong Kong. Six unique VR scenarios with corresponding facilitations are designed and implemented. Four of the six VR scenarios cover various social scenarios and social occasions of school life, including preparing for school in the morning, taking school bus to go school, having classes, reading and studying in the school library and buying food from the tuck shop. Besides that, one consolidation scenario helps children with ASD generalize what they have learned in the four training scenarios to other social occasions, and one relaxation scenario helps them to get used to the VR environment, learn coping skills and practice self-emotion control. The VR-enabled learning experience is delivered through a fully immersive 4-side CAVE™ installation [8] with head position and orientation tracking for perspective adaptation, which makes the scenarios extremely authentic to the children in terms of visual stimuli.

2 Related Work

Although the empirical and interdisciplinary studies on using VR and its enabling technologies for educational or therapeutic purposes only become popular in the recent years, the underlying theories and design guidelines have been proposed in the past.

Moreno [9] investigated empirically the affective factors on learning process. The author proposed a model that extends the traditional information processing model by introducing motivation, affect and self-regulation, three factors that are believed to be in close relation with our learning process. The model was then tested based on a set of studies conducted on various media, of which two studies are based on VR to deliver learning contents [10–12], the authors also investigated the interplay between emotion and learning. The novel learning model proffered in [12] is considered as one of the fundamentals in the research domain of affective learning. To study whether VR in combination with other sensory stimulations, as a media for content delivery, could induce better affective experience during learning, resulting better learning effectiveness, Kwok et al. at City University of Hong Kong used a multi-sensory multi-modal smart ambience environment called SAMAL for learning de Bono's six-hat thinking in an undergraduate course of information management [13]. Results from this empirical study showed that the VR experience positively influences the affective experience perceived by learners, which positively influence the learners' learning engagement, resulting in better learning effectiveness. Subsequently, Ip et al., proposed a pedagogical model for affective learning called The SAMAL model [14], which considered the incorporation of body, mind and emotion during the learning process.

In recent years, using VR and its enabling technologies for special education [15] and therapy for children with ASD has drawn a great attention of interdisciplinary scholars. Cheng et al. [16] designed a collaborative virtual learning environment to explore the efficacy of using such environments for empathy training of children with ASD. Three autistic children with relatively good verbal IQ, performance IQ, and full-scale IQ participated in the study. The virtual learning environment recreated several social occasions that could commonly appear in restaurants. Results showed that all three children improved in terms of understanding empathy after participating in the study, and such improvements could be generalised to their daily lives based on long-term evaluation and observation by their care takers. Lorenzo [17] investigated using VR as a tool to facilitate the acquisition of knowledge, improving social skills and improving performance of school tasks of children with Asperger syndrome (i.e., high functioning autism). The educational contents of this study were designed in the context of daily lives of school-aged young adolescents, and were delivered via an immersive L-shape two-screen stereoscopic projection system. Ten children from primary school and ten children from secondary school all with Asperger syndrome participated in this 40-week long study. By comparing pre- and post-assessments, the authors demonstrated the children' significant improvements on both executive functioning and social skills. Observations from the tutors of both schools also confirmed the children' knowledge generalisation and transferring from virtual reality environment to their daily lives. Similar positive results of using VR as a tool facilitating learning and therapy of children with ASD could also be found in [18–20]. However, none of these studies involved trials of the specifically developed virtual reality contents on relatively large number of participants with ASD. In this paper, we present our

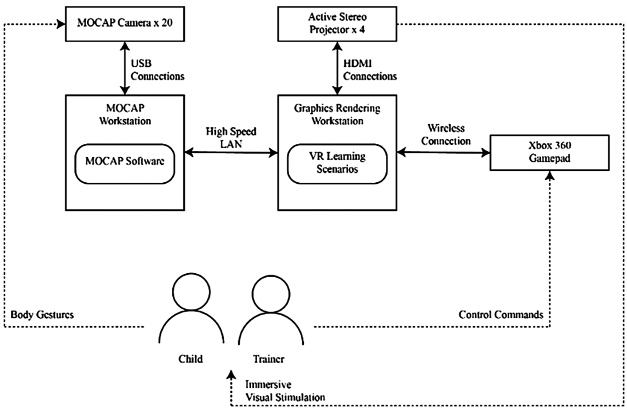


Fig. 1. Overall setting and data flow of the VR software and hardware environment

work in developing a series of virtual reality learning scenarios specifically designed for social adaptation training for school-aged children with ASD in inclusive education settings, and delivering such VR-enabled learning experience to a relatively great number of autistic children in Hong Kong.

3 Design and Methodology

3.1 Environment and Setting

The VR learning scenarios are delivered via a four-side CAVE-like immersive VR environment with head tracking for perspective adjustment. The whole software system is supported by two workstations for graphics rendering and motion tracking respectively, which are connected via a high speed local area network (LAN) for data exchange. During training sessions, the trainer is able to control the learning content via a wireless Xbox 360 game controller, while the children will mainly interact with the environment via body gestures and communication with the trainer. Figure 1 shows the overall setting of the VR software and hardware environment; Fig. 2 illustrates the four-side CAVE-like immersive VR environment.

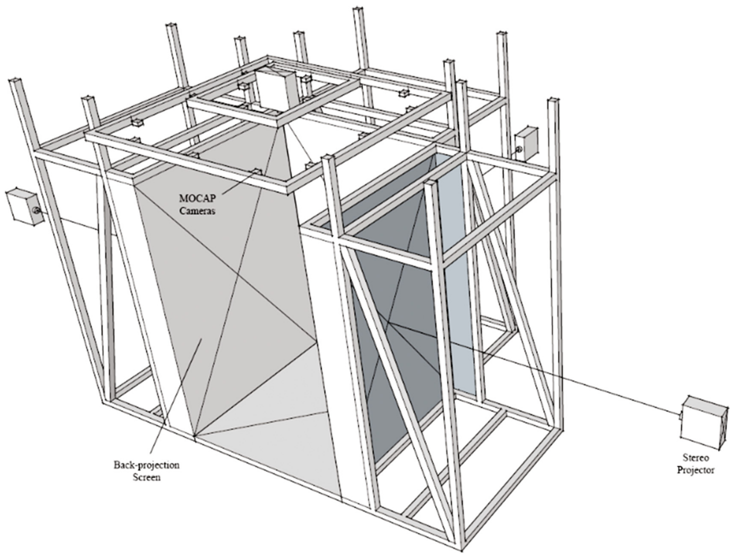
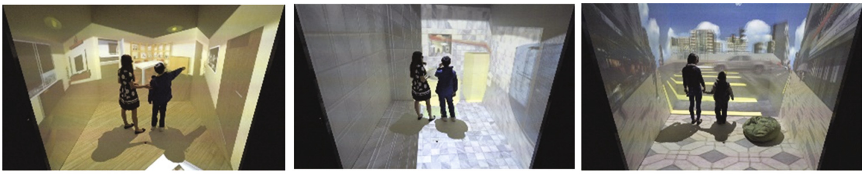


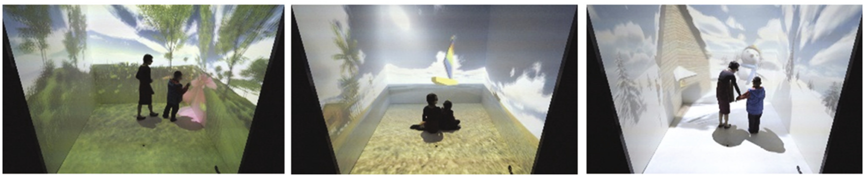
Fig. 2. Illustration of the four-side CAVE-like immersive VR environment

3.2 Scenario Design

The virtual reality learning scenarios are designed to provide an authentic, safe, controllable and manipulable environment, in which the school-aged children with ASD can practice their social skills and coping skills while avoid unnecessary embarrassment. Specifically, each of the six unique learning scenarios is designed with elements that could guide the children better understand their internal emotions, express their thoughts and feelings, appropriately response to challenging social occasions, develop empathy and generalise the knowledge and skills they are expected to gain in the VR to their daily lives with the facilitation of the programme trainers. Scenario 1 simulates the preparation of going to school in the early morning. The children will experience a series of preparation steps with a checklist as the visual cue, including wake up, use the toilet, wash hands, brush teeth, all the way to get to the lobby and wait for school bus. This scenario focuses on training the children's executive functioning [21]. Scenario 2 simulates the social occasions that could happen on the way to school and in classroom. A facial expression matching game adapted from [22] is included in this scenario, in order to let the children practice their facial expression recognition skills. The scenario also contains a series of routines that school-aged children will experience every day in an inclusive education environment.



(a)



(b)

Fig. 3. The VR-enabled learning contents are delivered to children with ASD via the four-side CAVE-like immersive VR environment under the facilitation of the trainers; (a) executive functioning training and social skills training; (b) children learn to express themselves, practice coping skills and relax in scenario 6 - four seasons.

Scenario 3 creates a virtual reality library, in which appropriate social behaviours are quite important. The children will be asked to keep quiet, look for an interesting book, share a reading seat with their peer children and check out the book at the library circulation counter. The children will also be challenged by inappropriate social behaviours of others. Scenario 4 simulates a tuck shop, from where children can purchase snacks and food. The children will be required to queue up and they may face challenging situations, such as the snack or food they choose has been sold out. Scenario 5 is designed for consolidation, in which the social skills, coping skills, other knowledge and skills the children have learned in the previous four scenarios will be tested and generalised to a new scene - having PE lesson on the playground. In scenario

6, children will be able to experience four different seasons with peaceful background sounds. This scenario functions as both an environment for new comers to experience and get used to the fully immersive VR setting, and a safe and relax place in which the children will be guided to calm down and express their internal feelings and thoughts. Figure 3 shows some of the virtual sceneries of the learning scenarios.

3.3 Method

Sample. Children from mainstream primary schools were referred to the team by the school social worker or special education needs coordinator if they have a diagnosis or a suspected diagnosis of autism spectrum disorder (ASD). The inclusion criteria specified that children must have a diagnosis or a suspected diagnosis of ASD and a full-scale Intelligence Quotient (IQ) of more than 70. All children were fluent in Cantonese or English. The children usually had poor social and communication skills and have difficulties recognizing and regulating their emotions.

20 children were recruited for pilot study that started in July 2015. There was one drop out due to inability to commit to the training. 19 children completed the training in October 2015. The children ranged in age from 6 to 9 years (n = 20, mean age: 7.00). Children were randomly assigned into one of five groups.

33 children were recruited for group 1 that started in October 2015. All 33 children completed the training in February 2016. The children ranged in age from 6 to 11 years old (n = 33, mean age: 8.67). Children were randomly assigned into one of ten groups. There were more children recruited and scheduled for group 2 and 3 which are yet to be completed.

Training Sessions. The training consisted of 28 one-hour sessions which spread through approximately 14 weeks. Each group consisted 3-4 children. Each session is broken into three parts: (1) briefing, (2) interactive training scenario in the CAVE™, and (3) debriefing. Each session begins in the discussion zone where the trainer reviews previous concepts and introduce the learning objectives and tasks of the day. After that, children will enter the CAVE™ and work with the training individually on the virtual reality scenario for that session. After all children have completed the training, the group returns to the discussion zone to discuss on what they have just experienced and to bridge the virtual learning experience into the real life. There are ongoing observations and weekly parental feedbacks throughout the training sessions in order to monitor the children' progress.

Measures. All children entering the study need to complete Raven Progressive Matrices Test, a nonverbal test of analytic intelligence [23]. Parents are also required to complete Childhood Autism Spectrum Test (CAST) to assess the severity of autism spectrum symptoms in children [24].

For the pilot group, 9 other assessments were administered at pre-assessment. Children completed 6 different assessments, including the, Faces test [25], Eyes test [26], Psychoeducational Profile - 3rd Edition (PEP-3) [27], Spence Children's Anxiety Scale-child version (SCAS-C) [28], Faux Pas Test [29] and Social Attribution Task

(SAT) [30]. There were also 4 parent-report measures, including Spence Children's Anxiety Scale-parent version (SCAS-P) [31], Children's Communication Checklist (CCC-2) [32], and Adaptive Behavior Assessment System (ABAS-II) [33]. These assessments assess the children's ability in emotion recognition, social perception, theory of mind, and adaptive skills. The SCAS-C and SCAS-P were administered in order to identify any possible anxiety that may inhibit their performances in the training. All of the above assessments were repeated at the end of the training program.

4 Preliminary Results

Paired-sample t-tests were conducted to compare the scores across different assessments before and after the training program. In terms of emotion recognition, there was a significant difference in the Eyes Test scores before training ($M = 12.4$, $SD = 3.41$) and after training ($M = 14.3$, $SD = 2.50$); $t(15) = -2.23$, $p = .041$, $d = .635$, where t denotes the t-value, indicating the test statistic, p denotes the p-value, indicating the level of marginal significance, and d denotes the Cohen's d, indicating the effect size between the two means. There was no significant difference in the Faces Test. For affective expression, there was a significant difference in the score before training ($M = 17.4$, $SD = 2.31$) and after training ($M = 19.1$, $SD = 3.22$); $t(15) = -2.87$, $p = .012$, $d = .607$. For social reciprocity, there was also a significant difference in the score before training ($M = 19.3$, $SD = 3.38$) and after training ($M = 21.4$, $SD = 3.48$); $t(15) = -2.52$, $p = .023$, $d = .612$. There were also overall significant differences for this PEP-3 score before training ($M = 36.7$, $SD = 5.44$) and after training ($M = 40.6$, $SD = 6.20$); $t(15) = -3.21$, $p = .006$, $d = .669$.

5 Future Work

The empirical study and its preliminary results presented in this paper clearly demonstrate the great potentials of using VR and its enabling technologies as a tool to facilitate social adaptation training for school-aged children with ASD. The study will continue and the scenario design, accompanied by the training protocols, will be further polished in order to better serve the psycho-educational purposes and to achieve better results. We expect the number of beneficiaries could pass 100 by the end of this study. Under the framework of SAMAL model and affective learning, we also plan to further expand and adapt the VR-enabled psycho-educational contents to cover other aspects of training and learning for children with ASD.

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Open and Flexible Learning

Adaptive E-Learning Textbook Evaluation Methods

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Abstract. In the last few years, the research at the University of Ostrava has been focused on the theory of adaptive e-learning and its testing in practice. Quality adaptable textbooks are essential in order for this type of education to be successful. The paper deals with one of the main parts of the stated issue – an evaluation of adaptive textbooks. Evaluation can be conducted (a) before the start of the education process, (b) immediately after the textbook has been inserted into the LMS, or (c) after the protocol of students' behavior in the on-line mode has been analyzed. The paper describes the theoretical proposition of one type of evaluation and its verification in practice.

Keywords: Adaptive learning · Individualized learning · Adaptive LMS · Textbook evaluation

1 Individualized and Adaptive Learning

Until recently, individualized learning, or the instruction of an individual was used rarely and only in extracurricular or optional education (in language schools, art study programs, sports schools, etc.). It could not be used at any level of common schools due to the high number of students and the number of students per teacher. Moreover, the used textbooks were intended for all students. Even though those textbooks were created by highly qualified pedagogical experts, they did not suit all students [1].

The development of computer networks and expansion of the Internet among the general public brought about brand new educational possibilities. However, the technical capabilities outpace pedagogical software. The e-learning capabilities are far from being used to the full extent as the same electronic textbooks for all students still prevail. The HW and SW tools would enable not only individualized instruction but also an instruction adapted to every student's characteristics and abilities [2, 3, 11].

The main reason why there are not different textbooks for different types of students is the insufficiently explored issue of student types, their learning styles, and the optimal methods for teaching particular types of students. It is a multidisciplinary issue which requires cooperation of pedagogues, psychologists and specialized informatics.

A team, which deals with this problem, has been assembled at the Department of Information and Communication Technologies of the Pedagogical Faculty of the University of Ostrava [1]. The abovementioned team of experts introduced the theory of adaptive education. The theory is being verified in practice and extended by the

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results of the related research. Apart from the members of the department, a number of Ph.D. students are working on the theory (several dissertations on the topic have been successfully defended) [1].

Generally, adaptation of education is the changes in the instruction of the same curriculum, but carried out in a different manner so it would suit every student's needs. Ideally, all capabilities of e-learning (i.e. the LMS tools) should be used. The Internet and computer can be used not only for presenting the created study materials but also for adaptation of education, i.e. automatic individualization of instruction according to what type of student it is currently teaching.

Automatic individualization of education solves a number of partial problems:

- characteristics that determine the student's learning style (LS),
- types of teaching styles (TS) and their characteristics,
- which TS to use for a particular student and their LS in order to achieve the best possible result,
- how to compile textbooks that would come in different TS variants for different LS,
- what instruction strategy should be used to achieve the consolidation of the acquired knowledge,
- what automatic methods can help acquire feedback on effectiveness of instruction.

Apart from the mentioned partial problems, a new learning management system (LMS) needs to be created for the proposed solutions because none of the existing systems contain those options.

The initial theory of adaptive education (TAE) offers one solution to the problems. We will introduce its basic principles. Moreover, we will highlight the characteristics used for the evaluation of adaptive e-learning textbooks.

1.1 Student and Their Learning Characteristics

In order for the program that manages individualized education to be able to manage it in an individualized manner, it needs to have information about the student's learning style (LS). A large number of theoretical pedagogues and psychologists deal with the LS theory. Those defined several characteristics – students' qualities – that influence LS. An extensive analysis helped define a tuple of mutually independent characteristics that determine the student's LS. They were published in [4].

The characteristics are: sensory preference of perception (verbal, visual, auditive, kinaesthetic), social aspect (prefers learning on their own, in a pair, in a group), affective aspects (motivation to study – inner, outer), learning tactics containing orderliness (studies systematically and sequentially or non-systematically and randomly), information processing (theoretical derivation, experimentation), information processing procedure (detailed – bottom to top, holistic – top to bottom), approach to study (depth, strategic, surface), degree of self-regulation – the ability to manage one's own studying. There is also the success rate (talent for a particular subject), which serves as a dynamic attribute.

1.2 Structuralization of Adaptable Textbook

It needs to be said that by an e-learning textbook we mean the complete study material which comprises not only the text part with images, graphs, etc., but also the accompanying multimedia, videos, animations, supporting pedagogical SW, single-purpose study programs, websites, etc.

As far as adaptability is concerned, another question arises: What methods should be used to make the textbook adaptable to every current student's LS?

One of the possibilities, preferred by the majority of experts specializing in LS, is to create a different version of the study material for every student type (often named). As far as 2-3 qualities with two poles (has – doesn't have a quality) are concerned, the amount of variants is reasonable. However, for a higher number of characteristics the amount of variants would be unacceptable (e.g. with only 2 values of each quality for the 14 characteristics that form the basic model, the number of variants would be $2^{14} = 16{,}384$ types) [5].

Therefore, another way has been chosen. The characteristics, which require the curriculum formulated in a different manner, will be created in variants: 4 sensory variants (which require the use of different "active" words in the text and different types of multimedia) and the success rate (which requires a different level and extent of instruction). 3 levels of the depth of instruction have been chosen. Overall, there will be $4 \times 3 = 12$ variants of instruction.

The remaining characteristics will be approached in a different manner. The textbook will be divided classically into chapters or units. The unit contains new information, i.e. new terms. We named the unit of information (e.g. one new term) a frame.

The analysis of how the variants of the study material should differ with regard to different values of other students' qualities has led us to conclusion that they differ especially in the order and the choice of sub-sections within the frame. For instance, a theoretically equipped and successful student appreciates the following order: theory, explanation, examples, verification; an unmotivated and less successful student, on the other hand, would need motivational examples, a more detailed explanation, theory, verification and a motivational praise. The "rules" for the adaptation (i.e. choosing and sequencing the sub-sections of the study material in order to fit every student's LS) can be formulated in a similar manner. As a result, every frame has been divided into layers. The following layers have been defined: instructional (theoretical, semantic, fixation, of solved examples and of practical examples), testing (theoretical questions, tasks and practical tasks) and special (motivational, navigational, formulation of aims, literature). These layers have been proven to be in accordance with didactic principles, Gagné's theory of the education process and other pedagogical-psychological principles [5].

As a result, the instruction has been divided into units and frames with each frame containing sensory and depth variants, which are further divided into layers. Neither variants nor layers are obligatory. The author of the study material decides which of them is appropriate for a particular subject.

1.3 Rules for Assigning Teaching Style to Student with Known Learning Style

We named the program, which manages individualized education, the Virtual Teacher (VT). The program modifies the author study material, which is structured into frames, variants and layers, to create an optimal version of the study material for the current student defined by their LS characteristics. The entire process is divided into 2 phases.

In the first phase, the VT defines the so-called optimal learning style (OLS) of the current student, i.e. it creates a theoretically optimal selection and sequence of every frame's layers which is valid for any study material. However, the actual study material does not need to contain all the variants and layers for every frame (see the end of Paragraph 1.2) [6].

That is why there is the second phase of the VT, which is realized for every current frame one more time: based on the student's OLS it defines the so-called actual learning style (ALS) where the frame adaptation is adjusted to a real frame. Possible missing variants or layers are replaced by the closest ones or omitted entirely [7].

1.4 Realization of Adaptive Education Through Adaptive LMS

The proposed detailed theory of adaptive education needed to be verified in practice. As there was no LMS that could take a detailed study material and – through the use of the expert rules – make it into the optimal version of a study material corresponding to a particular LS, it was necessary to create it. In 2010–2012, students and teachers of VŠB-Technical University of Ostrava and the University of Ostrava collaborated on the development of such system, which was realized as the LMS Barborka 4 (versions 1–3 contained only partial solutions of adaptivity). The research was supported by two ESF OP VK projects. The system is still being developed; new functions and rules are being added [8].

The entire LMS is divided into the following modules: Student (identification of students and a questionnaire to determine their initial characteristics + instruction), Author (storing and modification of study materials), Expert (algorithms of the Virtual Teacher, an expert system for the rules of the VU, a system for the data analysis), Tutor (organization of instruction, submission of tasks, realization of tests, etc.), Admin (system administration). The Student, Author and Expert modules are important for adaptivity. First of all, we will describe their original scope. The following chapters deal with the addition of two sub-modules to the Expert module, which are used for the evaluation of textbooks.

1.5 Author Module and Creation of Study Materials

As has already been mentioned, it is the author who decides about the factual content of a study material. However, as the study material needs to be adjusted to the requirements for the structuring of a workbook into frames, variants and layers, the author needs to become acquainted with the TAV, the methodology of the processing of variants and the meaning of layer types.

As far as the sensory variants are concerned, the author needs to become acquainted with the recommended formulations of different sensory types of students. And as the author often belongs to one of the types, their language is influenced by that type. As a result, they need to learn to express the same sentences using a different language for different sensory variants. For instance, when addressing the auditive student the author should use "auditive" words such as "let's listen to", "let's discuss", "the sentence goes…", etc.; the visual student "visual" words such as "we can see that…", "let me show you…", "varied", etc. The author should follow the same pattern when addressing the other sensory types [5].

As far as the depth of the instruction is concerned, the author needs to imagine they are instructing the average student. To this, the author needs to add something for the above-average student so they do not become bored. For the slower student, on the other hand, they need to make the instruction more detailed and adjust its pace.

1.6 Student Module and Instruction

The Student module is user friendly. After the first log-in the student is asked to fill out a questionnaire from which the initial LS characteristics are determined. The questionnaire was compiled by a psychologist.

Afterwards, the student chooses the course and unit. Then they are presented with a series of frames in the sequence of layers adapted by the VT according to their LS. The student (as it is usual in e-learning) chooses their own pace of instruction. However, the student does not have to follow the variants and the sequence of layers offered to them by the VT. At any time the student can choose any existing neighboring variant of instruction (of any sense or depth) or move on to another frame in the unit.

The student's every "mouse click" in every mode is recorded in the education process protocol. The analysis of the protocol can reveal interesting facts about the student, the study material or the rules for the management of instruction.

2 Further Research Concerning Theory of Adaptive Education

The TAV published in 2012 [1] defined the basic principles of the adaptation of study materials based on particular students' LS. A number of other pedagogical-psychological and implementation problems related to the theory were defined during the realization of the principles in the LMS, their verification, pedagogical experiments and theoretical discussions of the entire group of researchers. We will present the ones that have already been solved.

The professional and didactic level of the adaptable textbook is an important factor conditioning the quality of instruction. Since it is a new approach to the adaptability of study materials, the authors are not experienced enough. Originally, only 12 such textbooks were created, each of them only for several units. Subjects from various fields were intentionally chosen: foreign language (English), science subjects (mathematics, biology, physics), technical (material science), informatics (algorithms and programming, databases, digital photography), pedagogical (e-learning technology).

First, every author created their own study material. Afterwards, a number of seminars were held during which every author presented their experience and propositions concerning methods for the creation of the textbook and its variants. It was interesting that all the authors agreed on the same optimal approach to creating the textbook. Based on this result, an MS Word "form" was proposed for the authors, which was used from then on. The form contains not only a predefined basic structure of the frame with its layers, but also a place for the accompanying metadata which the author must state whenever they are inserting anything into the LMS.

The pattern was then successfully used by other authors. It is not appropriate to insert the newly created parts of the study material directly into the LMS because they are often modified.

That is how the technical part of the creation of the adaptable study material was carried out. However, the issue of the professional and didactic evaluation of the textbook remains unresolved.

Two dissertations of students of the ICT in education study program dealt with evaluation. However, they used different methods and evaluated different facts. First of all, we will describe general methods of evaluation and then proceed to the description of the two newly proposed methods. What makes them interesting is the fact that they are carried out without further involvement of authors or opponents.

3 Evaluation of Textbooks

Evaluation or grading is used in all areas of life. However, not always is it called evaluation. In pedagogy, evaluation is sometimes divided into:

- Evaluation of educational needs,
- Evaluation of educational programs,
- Evaluation of the educational environment,
- Evaluation of textbooks,
- Evaluation of real instruction.

We will focus on the last two points. From now on, evaluation of textbooks will denote all methods which can contribute to the evaluation of the instruction success rate according to the evaluated textbooks:

- Professional or pedagogical **reviews** are often used. They are written by reviewers (experts in particular fields) when a textbook is created but before it is used in instruction. Sometimes the so-called layman review is used, which is written by a potential student. Based on the suggestions stated in the review, the author of the textbook can modify the problematic parts.
  However, experience shows that the reviews not always stress all the imperfections. It depends on a reviewer's personal opinion on the form of instruction, the detail of the review and a number of other factors. The reviews usually reveal the obvious professional errors.
- Especially at universities, evaluation questionnaires or written suggestions written by students – the ones who already completed the course in which the textbook is

used – are a necessity. As far as daily attendance study is concerned, the evaluation cannot distinguish between the influence of the textbook and the teacher on the overall contentment of the student with the instruction. As far as e-learning education is concerned, the influence of the textbook prevails. As a result, a student evaluation is of greater importance.

Once again, experience shows that opinions of students and reviewers on the quality of the textbook differ. Both students and teachers can prefer different points of view.

- When instruction is managed by the LMS, the student's behavior when they are logged in the system is often recorded. Usually, the student's every mouse click on the following function in the system is recorded. The detail of the protocol depends on how detailed the structure of the textbook is. However, not always is the protocol automatically analyzed. In such cases the teacher needs to analyze it by themselves [9].

4 Evaluation with Support of Semantic Network

Instruction supported by the semantic network is the original way of expanding the possibilities of the LMS [10]. The semantic network is a graph of the nodes-edges type where the node represents the term and the edge in between the nodes represents the relations between the terms. In reality, there are various types of relations between terms.

The original semantic networks describe terms and their relations in reality. Both instructional and professional texts should reflect reality and offer the interpretation of terms which is in keeping with didactic principles. Even an experienced author can sometimes violate the rules. Thanks to their detailed structuralization and distinction of the semantic meaning of the partial layers in the text, study materials in adaptive e-learning enable students to recognize, register, visualize and find didactic errors in terms and relations between them. The SNT created above the study material is the optimal tool for this purpose.

The author can find the preview of the author text structure interesting for a number of reasons:

- It verifies whether the study material describes reality correctly, whether it is in keeping with didactic principles (e.g. whether there are enough examples for a particular term, etc.).
- The interdisciplinary use of the SNT will make it easier for both authors and students to compare definitions of terms, or will notify the author of any discrepancies.
- The interdisciplinary use of the SNT will notify the author of any redundant duplicity in instruction or any possible differences in definitions or their interpretations.

4.1 SNT Definition for Textbook

An SNT can be created above every adaptively processed textbook. First of all, basic terms of the network need to be defined [10].

In this case, a **term**, which constitutes a network node, is a defined word or a phrase which the author marks in the place of its definition and which is a part of the study material.

A **synonym** is another word or phrase defined by the author which is synonymous with a previously defined term.

An **occurrence of the term** is a term or its synonym which is automatically found in the study material.

A **relation** is an interaction between two terms.

A **meta-relation** is an interaction between a defined term and its automatically found occurrence.

There are several types of nodes in an SNT:

- The first type contains a *term* defined in the theoretical layer and its *synonyms*,
- The second type contains the *occurrence* of the term in the text – automatically found in any layer. The *occurrence* of the term can be further distinguished according to where in the text it occurs with regard to its definition:
  - *Occurrence before* definition
  - *Occurrence after* definition

A *predecessor* of a particular term is a term (and also a type of node) which is included in its definition. A *successor* of a particular term is a term which is needed for its definition.

Various types of *relations between terms* can be defined in a semantic network. The following are those of them that can be used for the visualization and evaluation of the study material:

- is a hierarchy (the ancestor-descendant relation),
- is Predecessor,
- is Successor.

Similarly, various types of relations between a term and its occurrence, i.e. meta-relations can be defined:

- occurrence Before,
- occurrence After.

The relation *occurrence Before* the definition is a meta-relation between a term and its occurrence where the same term occurs before its definition in the author text. This can suggest an incorrectly introduced term. The meta-relation *occurrence After* the definition means that a term is defined first and then used (which is the correct pattern).

The semantic network (SNT) in the Barborka 4 LMS [10] is defined for terms that are defined in the study material, namely in the theoretical layer. They are highlighted by the author of the study material who can also add their synonyms.

After the study material has been inserted into the LMS, the particular SNT is created automatically with no further intervention from the author. Apart from the

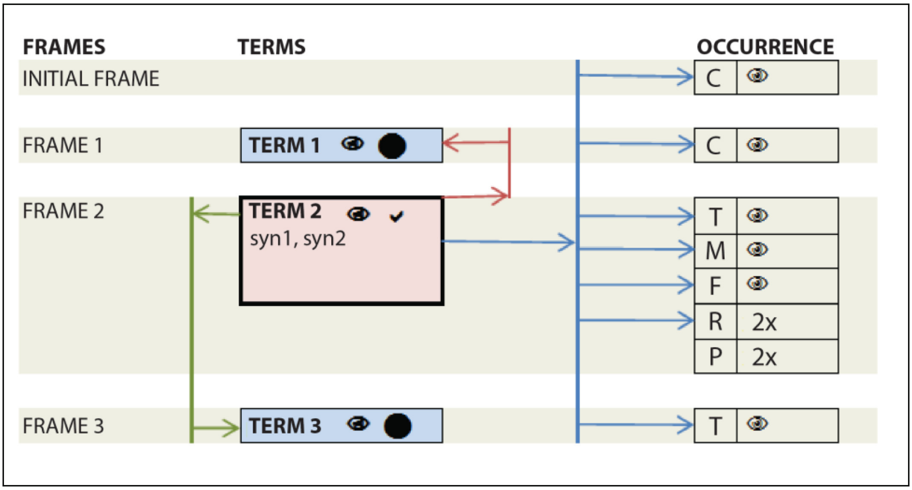

Fig. 1. Visualization of part of automatically generated SNT

visualization of the network of terms, how they are gradually being defined and used in the SNT (see Fig. 1), the entire structure is inserted into the system database. As a result, a number of analyses can be conducted, which will ensure that the main pedagogical and didactic principles are respected [10].

4.2 SNT Contribution to Author

The SNT provides the author with an automatically processed didactic evaluation of the study material. Based on didactic principles, it generates a list of errors or a notification of possible errors. It makes sure that all the instruction phases are complete and that the sequence of the introduced information is correct. The MS Word functions can help the author check the grammatical and stylistic aspect. However, automatic control of the text of the study material does not exist yet. Didactic principles or the factual accuracy of instruction cannot be automatically checked. However, an analysis of the structure of the text and a number of pedagogical characteristics is available.

The didactic principles have been known for centuries. They are didactic rules that are supposed to ensure the effectiveness of instruction. They are the most general recommendations for teachers, which, if respected, can lead to the teacher, when teaching, or the student, when studying, achieving the maximum efficiency. Jan Amos Komenský (1592–1670), a founder of modern pedagogy, was the very first creator of the pedagogical system. Nearly all the other pedagogical theoreticians follow up on his work. His original principles have not changed much. Some of them have been slightly reformulated, and a number of new ones have appeared. These are: the principle of transparency, the principle of orderliness and consistency, the principle of activity and awareness, the principle of permanency, the principle of adequacy, the principle of teaching from the least difficult to the most difficult, the student should be the teacher, instruction should be enjoyable, the principle of the student's complex development, the principle of scientism, the principle of the interconnection of theory and practice, the principle of an individual approach, the principle of emotionalism, the principle of feedback.

On the basis of those principles a detailed analysis of their manifestations and violations in the analyzed textbook was conducted. The majority of the principles can be checked by the SNT.

The SNT automatically generates reports of various importance.

- Informative report (i) – informs about possible incompleteness of instruction – appropriateness of additions to the text,
- Warning report (w) – informs about a minor error,
- Error report (e) – violation of a principle.

Due to a large number of errors, we will include only those of them pointing to a violation of one of the first two principles.

Principle of Transparency

Students already have an idea about the studied curriculum. Those ideas have to be approached in a way that would help students remember and understand the curriculum. Through the use of **tools and a didactic technique**, the teacher helps students create and generalize their ideas through immediate perception of reality or its depiction. The teacher can also apply an instruction technique that invokes in students the **already existing ideas** of the described reality, i.e. natural or artificial subjects and natural or social phenomena [12]. The instruction activity should **activate the greatest possible number of senses**, it should help develop the student's imagination and enrich and cultivate their personal experience. Sensory perception enables the student to form an opinion on things and phenomena which they can transform into terms. Transparency is beneficial especially for inexperienced students, i.e. a transparent demonstration mediates direct experience and makes the transition to abstract thinking easier for the student.

Rules for evaluation of a principle in the study material:

- Activate senses → variants of at least 2 sensory forms,
- Use various transparent tools → audio, video, schemes,
- Use the already existing ideas → the fixation layer,
- Transparent demonstration → solved and practical examples and tasks.

Error reports following the checking of the principle of transparency:

- the term is not to be found in the following instructional layers: fixation, solved examples, practical examples
- the term is not to be found in the following frame testing layer: tasks and practical tasks
- the term is to be found only in layers of one of the frame sensory variants.

Principle of Orderliness and Consistency

The curriculum should be logically organized according to the didactic system; a **term should be defined first and then used**; educational units should logically follow each other; the curriculum should be **taught from the least difficult to the most difficult**, from the close to the distant, from the concrete to the abstract, from the general to the particular, **from the known to the unknown**. Logical and systematic organization makes the curriculum easier to remember. Demands on students should be increased gradually, basic topics of a particular scientific discipline should be discussed and the **instruction should be evaluated continually and systematically** [12]. The requirement of consistency applies not only to the content of the curriculum but also to the methods of instruction. Therefore, it is necessary to constantly revise, practice and continually encourage the student to study and systematically evaluate their results (through feedback). The student should learn to work regularly and systematically, which forms their personal learning and working style.

Rules for evaluation of a principle in the study material:

- New terms → a term needs to be defined first and then used (with the exception of special layers),
- Logical sequencing → basic terms need to be defined first, followed by the more complex ones,
- Consistency → information about the time spent on a unit in the navigational layer (for every unit), tasks with a deadline,
- Orderliness → information about possible further studying – next week, in the next chapter, a unit in the navigational layer to motivate the student to study,
- Motivation → adding examples from practice, where the new curriculum can be used,
- Continual and consistent evaluation → adding questions and tasks to every term.

Various reports following the checking of the principle of orderliness and consistency:

- the term is not to be found before the definition in instructional or testing layers XYZ
- the predecessor is defined after the successor
- the term is not to be found in the examples from practice.

The other principles are dealt with in the same manner. The author can generate them anytime and based on the result, they can modify the textbook or generate them again, until they are satisfied with it. Sometimes, however, the author chooses not take some of the “error reports” into account.

A textbook with 7 units, 37 frames, 37 terms, 23 synonyms and 163 layers was used to debug the implementation of the SNT. In order to verify the proper functioning of the program, the textbook contained errors. After the textbook had been inserted into the adaptive LMS and the SNT had been generated, 422 key terms or their synonyms were found. At first, there were many informative and warning reports, some of which appeared in more than one principle. The continuous modification of the textbook reduced their number. The author can highlight the reports which they consciously disregard so they are not mentioned next time.

5 Conclusion

The main contribution of this type of feedback in adaptive e-learning can be divided into two parts: (a) how it benefits the study material and (b) how it benefits the author of the study material. The first contribution of the proposed evaluation process can be seen when evaluating the study material. The structure of the study material should be created according to the pedagogical principles for the creation of study materials. The evaluation of the study material's structure is carried out according to the pre-defined rules. When the study material's structure contradicts the principle, the second contribution of the evaluation process can be seen – recommendations, on the basis of which the study material should be modified, are proposed to its author.

In conclusion, we can say that:

- The formulated theory of adaptive education was incorporated in the new type LMS, including all of the described possibilities of automatic adaptation of the study material according to the individual characteristics of the student's learning style;
- The theory has been expanded by the use of the semantic network of terms for pre-evaluation and better orientation of the student and the author in the structure of terms;
- The abovementioned theory and evaluation method have been verified by a pedagogical experiment and an author review, and that the theory has been implemented into – so far pilot – practice in a number of subjects.

The proposed theories did not remain only at the theoretical level as there are tools for their practical use.

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Research of Learning Strategies in Flipped Classroom a Case of Extra-Curricular English Study

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Abstract. In recent years, flipped classroom has been more and more popular in education field. Since the second half of 2013, the learning process of students in an extra-curricular English teaching institution has been studying, where the teaching model of flipped classroom is used. With qualitative research method, research objects are four students and a teacher in one class. After data analysis, the article gets three conclusions: Firstly, learners prefer taking notes online to doing that in face-to-face class. Secondly, in the flipped classroom, it is very important for teachers to build knowledge construction and summarizing. Thirdly, from the perspective of theory, flipped classroom provides the chances of repeating learning for students. However, in practice, to fulfill repeating learning, learns also need intrinsic learning motivation.

Keywords: Flipped classroom · Learning strategies · Teaching model

1 Introduction

Since the rise of flipped classroom in recent years in the United States, many Chinese schools and institutions have begun to practice this model. Different from traditional teaching method, in the flipped classroom, students complete learning the knowledge at home, and the classroom becomes a place of interaction, communication, collaboration and support among peers or from teachers.

The study reported in this article tries to explore the students' learning process, behaviors and strategies, making field study in an extracurricular English institution where teachers are using the flipped classroom. The article will try to explore two points from the perspective of learning strategies: Firstly, what are students' learning strategies like in flipped classroom? Secondly, what effectiveness and impact can flipped classroom bring from the perspective of learning strategies?

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2 Related Theory and Research

2.1 Flipped Classroom

Flipped classroom, also known as reverse classroom, reverse teaching and flipping the classroom, is a new educational model. For the definition of flipped classroom, scholars have not given one uniform definition.

Some scholars argue that in traditional teaching, the teacher explains knowledge in class, and students complete in-depth understanding through homework after class; In this new model of flipped classroom, students learn knowledge after class and achieve in-depth understanding in class through participation and interaction. Researchers call such a model as "flipped the classroom" [1].

According to the concepts proposed by the scholars, I refine the concept of flipped classroom in this paper as: Flipped classroom is a new kind of teaching model. In flipped classroom, teachers make teaching videos through the means of modern technologies, which consist of knowledge which they need to teach in class in traditional teaching, and students need to grasp the provided learning resources. While the face-to-face class is used to carry out questions, interactions, activities and further knowledge.

2.2 Learning Strategies

The systematical study about learning strategies was conducted from 1956, when contemporary cognitive psychologist Bruner began the study of artificial concepts. Learning strategy is one of educational psychology research topics and is a famous research point recently. Many studies show that learning strategy is an important factor affecting students' learning efficiency [2].

Rebecca L. Oxford thinks that learning strategies are specific actions taken by the learner to make learning easier, faster, more enjoyable, more self-directed, more effective, and more transferrable to new situations. O'Malley and Chamot [4] argue that learning strategy means special thoughts and behaviors used by learners to help learn and remember new information. Xuejing Wang (2009) thinks that learning strategies are learning methods or learning plans to fulfill learning goals.

According to above ideas, the researcher thinks learning strategies are specific methods, skills and procedures used by learners in order to achieve better student learning.

Through the investigation and study of 10 non-native English learners who are excellent English learners, Limei Yi (2007) summarizes the most effective and most frequently used learning strategies according to learning theories such as the meta-cognitive strategies and cognitive strategies: Making plans, self assessment, taking notes, association and affective strategies. O'Malley and Chamot [4] gives the classification of learning strategies in his monograph: repetition, grouping, summarizing and taking notes.

The above classifications are very enlightening, especially the dimension of "repetition". According to the theory of flipped classroom, one of the features of flipped classroom is that students can repeat learning the teaching resources provided by teachers after class. Therefore, this paper will consider the learning strategy of repetition.

Making a suitable learning plan can help students achieve learning goals, temper learning wills, and develop good learning habits. What's more, making learning plan is conductive to the improvement of students' sense of time and skills of making plan (Youyan Liang 2014).

Ausubel's meaningful learning refers to the connection of new knowledge and original knowledge, while taking notes is a one of ways of connection (Pijun Liu 2013).

In summary, this study pays attention to the students' learning strategies in flipped classroom: making plans, taking notes, and repetition.

3 Research Design

3.1 Research Methods

In the qualitative research approach, the researchers themselves are as research tools, and a variety of data collection methods in the natural situation are used to explore the social phenomenon, using the inductive method to analyze the data and come to conclusions. It is a kind of activity in which researchers interact with research objects to obtain explanatory understanding through the way of constructing objects' behaviors and meaning (Xiangming Chen 2000). In the qualitative research, researchers are used to using some unstructured interviews and direct observations. This paper is about the learning strategies in flipped classroom, which is a kind of process research, and researchers need a long time to observe and communicate with research objects to get understanding of their situation, their thoughts and their behaviors, to get know of their change in the process. Therefore, qualitative research is very suitable for our research.

3.2 Research Objects

The researcher field studies one extra-curricular English institution, which is using flipped classroom model in teaching. We choose one class with four students (Their names are Jack, Lily, Quncy and Kitty) and their teacher, Ms Zhou. The four students correspond to the fourth grade in regular schools. They are around 10 years old.

3.3 Teaching Model

In this institution, the teaching model used is flipped classroom. Teachers make teaching resources in the form of videos, design learning tasks and develop teaching games. Students need learn the lessons for five times every week, finishing learning the teaching resources and completing corresponding tests. After those, students need to have a weekly face-to-face class, where teachers can help students solve some confusing questions students meet when they learn after class. In face-to-face class, teachers would communicate and interact with students, and they can design some tasks to apply the knowledge students have learnt.

According to the features of flipped classroom and the subject of English, we construct the teaching model flowchart (Fig. 1).

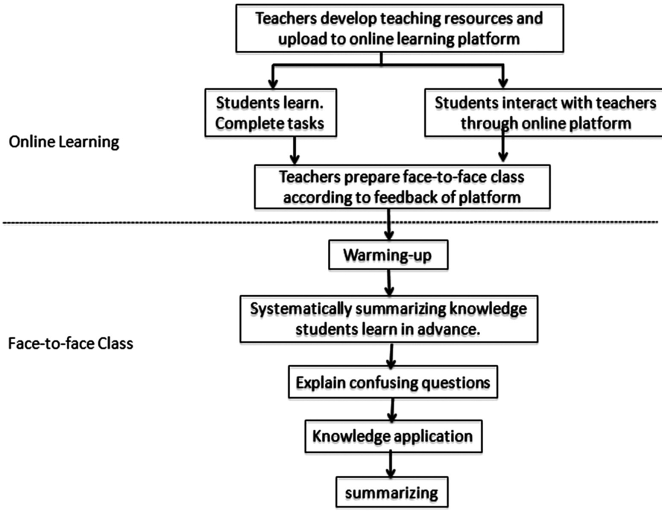

Fig. 1. Teaching Model

3.4 Teaching Dimension and Tools

In flipped classroom, students need to have both face-to-face class and online learning after class. Therefore in the table of dimension, face-to-face class and online learning are both considered. According to the former theory foundation and analysis, dimensions of learning strategies will be classified into learning plans, taking notes and repeating, as shown below (Table 1).

Table 1. Dimensions of learning strategies

Environments	Dimensions
Face-to-face Class Learning	Learning Plans, Note Taking, Other strategy
Online Learning	Learning Plans, Note Taking, Repeating, Other strategy

About the above table, we need to explain two points: Firstly, in the model of flipped classroom, students can repeat learning knowledge online, so we add "repeating" the element in the Online Learning part.

Secondly, in addition to learning plan, taking notes and repeating, we want to try to find students' other learning strategies, so we add "other strategy" to leave some space for our findings.

We compile a classroom observation form and three interviews questions outline for students, teachers and parents respectively to collect relevant data.

4 Data Analysis

4.1 Learning Plans

We get to know students' learning plans by the way of interviews and classroom observation. Four students hardly have the habits of making plans, and some of them do not even know what the learning plan means. Below shows dialogues about "make learning plans or not".

> Researcher: Do you make your own learning plans?
> Jack: What is learning plan?
> Quncy: Learning plan is how to preview, how to review and how to study.
> Researcher: Yep.
> Jack: No, I don't make plans.
> Ms Zhou explains: "Jack's answer can represent most people's thoughts. In our institution, teaching schedule are generally arranged by the teachers ahead of schedule. Students only need to follow the pace of teachers. They do not need and are not good at making learning plans."

4.2 Taking Notes

(1) Online learning

About whether students would take notes in the process of online learning, we collect data and analyze data by way of interviews with the teacher and students.

> Researcher: Do you take notes when you learn online at home?
> Jack: Yep! I would write down those new words in my notebook. (His expression shows that he is so proud!)
> Quncy: I would write down many things, such as the words not learnt before in the reading resources provided by teachers as supplement knowledge.
> Kitty: Yes. I would reorganize words in the Study Map.
> Researcher: Only in Study Map? Would you use other notebook?
> Kitty: No.

Then I asked further questions about the "Study Map", which is a notebook provided by the institution. Students need to write down knowledge points according to the guidelines in the notebook designed by teachers. For example, in Lesson 1, one of subjects is organizing words about "animals", Jack collects four words from online learning: panda, fox, lion, tiger. Another subject is "colors", Jack collects the following words: green, red, yellow, blue, black, orange. About grammar, Jack collects the following contents:

1. plural of nouns which don't follow general rules.

   Boxes, buses, fishes, matches, volcanoes, potatoes, tomatoes.

2. the third person singular form of the verbs which don't follow general rules.

   Mixes, washes, passes, watches, does, have-has, go-goes.

Maybe four-grade students are not very familiar to the concept of notes, but the guideline of the notebook and leading of teachers have helped students to develop the habit of taking notes, which is helpful to students' learning effects.

(2) Face-to-face class

At face-to-face class, the teacher would require students to write down their notes, and this activity is designed as a competition according to the numbers of the note contents. According to our observation at class, students are very active in this tasks and it is a motivation to their taking notes of online learning. The following is a slice of interview about students' taking notes.

Ms Zhou: Jack, why do you make mistakes in this question?
Jack: Because I don't know the meaning of 'train'?
Ms Zhou: Then you need make some notes to mark the meaning of 'train'. Write down the Chinese meaning'火车'.
Jack: OK!
Kitty: Then do I need to write down the meaning?

From the above dialogue, it is not difficult to see that in Kitty's mind, whether she takes notes is decided by if her teacher asks, not by her own learning needs.

What is more, it is not just students that think in that way, but teachers have such subconscious. The researcher made an interview to the teaching director in this institution, and she said, "We don't make serious requirement about students' taking notes. You see, there are detailed grammatical introductions in the back of the book. Only in some relatively high level class, in which I supply additional supplement content, at this time I will ask students take notes in their own books."

From the teacher's statement, it is not difficult to see that in this teacher's mind, "whether students take notes" is also decided if the teachers 'require' to do that.

We think that taking notes is a very important and effective learning strategy. Taking notes with "Study Map" has been a main form of the four students' taking notes. In online learning, students would take notes as they study learning resources.

4.3 Repeating

In theory, according to the features of flipped classroom, students can adjust their own learning pace. Excellent students can pass knowledge they have grasped quickly. While underachievers can repeat learning knowledge still confusing to them when they study once, which is an advantage in theory. However, there exists a gap between theory and practice. In the four students, only two students would repeat learning contents, and the main motivation is: Firstly, She could not understand the knowledge so she needs to repeat the video, hoping to understand them. Secondly, there is a test in every lesson. When she is not satisfied with the score, she can turn off the system so that she can do the test again to get a higher score. These two students (Lily and Quncy) are excellent students in this class, while the other two (Jack and Kitty) have relatively learning difficulties. Jack and Kitty do not often repeat the teaching videos for better understanding, instead they only pursuit completing watching the videos and completing the tests. They do not pay much attention to whether they grasp the knowledge.

Therefore, we think that online learning provides possibility of repeating learning for students, but the key point is learners' intrinsic learning motivation.

4.4 Other Learning Strategies

In the process of researchers' class observation and our further study, we try our best to keep an open mind to find whether students have other learning strategies. However, we don't find that, while we find that the teacher has a very good teaching strategy. We notice that in every face-to-face class, Ms Zhou would make a summary of the information of knowledge that students have learnt in online learning system in advance, which makes me think of the theory of "schema". In consideration of the close ties between teaching and learning, we think the discussion of teaching strategy in this paper is still very valuable.

The origin of the concept of schema can be traced back to the 18th century. In 1781, German philosopher Immanuel Kant proposed the concept of cognitive schema, and he thinks that concepts are not stored in memory in isolation, but interrelated, and constitute cognitive structure schemata reflecting interconnected things in reality [5].

Currently, many studies have revealed the differences in the process of knowledge between poor children and normal children (schema in particular) from different perspectives [6]. For example, Lawson and Chinnappan insist that effectively organized knowledge would be more likely to be closer, and more likely to be linked. If this is correct, structure of knowledge or degree of organizing of schema will have an important impact on students' learning [3].

An important feature of the schema is that "schema comes from repetition". Fundamentally speaking, generation of schema is constant repetition of knowledge derived from a unified category.

Every time when people encounter a strange member in this category, even if it mutates in some small points, people can still recognize it as a typical member of this category because it has some similarities with other members [5].

For example, many countable nouns' plurals are not just adding "s" to the nouns' singular forms. But there still exists some patterns. Ms Zhou has helped students summarize these patterns. She tell students that plurals of those nouns ending with 'f' or 'fe' are changing 'f' or 'fe' into 'ves', such as leaf - leaves, wife - wives, and the thief - thieves. This kind of summarization can help students develop the schema to help students find the prescribed rules to improve their English learning effects. Afterwards, they can use the rules to change singular to plural forms when they meet these kinds of words.

We think that, in the face-to-face section of flipped classroom, sometimes teachers pay too much attention to the designing and organizing activities. They often ignore helping and guiding students to summarize knowledge structure. However, from the former theory introduction, we can know that schema is very important for students. In the self-learning, it is difficult for students to creating their knowledge structure. Therefore, it is necessary for teachers to help and guide students to complete this important step.

In Ms Zhou's class, she helps students summarize knowledge structure in every face-to-face class. The researcher thinks that she confirms the theory of summarizing and schema, which can be elevating experience for other teachers.

5 Conclusions and Implications

5.1 Conclusions

According to the data analysis, we get the following conclusions:

1. **Learners prefer taking notes online to doing that in face-to-face class.**

According to the former data analysis, in online learning, teachers provide guidelines about how to take notes. These four students have been used to taking notes, for example, summarizing words about the subject of "furniture" and "color", or summarizing grammar about plural of nouns and the third person single form of verbs. Students do the summarization as they learn online.

Besides providing guidelines of notes for students, teachers ask students to show their notes achievement in face-to-face class, which is some kind of motivation to students' taking notes after class.

2. **In flipped classroom, it is very important for teachers to build knowledge construction and summarizing.**

In flipped classroom, the learning resources provided for students are often fragmentary and short, while the structure of knowledge is very important for students to understand and master knowledge. According to the inspiration that the schema theory gives us, concepts are not isolated stored in memory, but are interrelated. Structure of knowledge or schema has a great influence on students. Summarizing knowledge structure systematically is attached much importance by teachers in the traditional classroom. While in flipped classroom, students' performance is concerned much and paid much attention to, which causes many teachers to pay much more attention to the design of activities and interaction with students, but ignore the summarization of knowledge structure.

Even though learning strategy is the main subject in this paper, learning and teaching have very close connection and summarizing is valuable to students' learning effects. Therefore, we emphasize this point in this paper, and this point is a very meaningful discovery in our study.

3. **From the perspective of theory, flipped classroom provides the chances of repeating learning for students. However, in practice, to fulfill repeating learning, learning motivation is needed.**

We think that this is a very interesting conclusion. Because scholars generally believe that the model of flipped classroom can better help underachievers follow the learning pace, through the suspension and repeating learning. However, according to our observation, some of these underachievers' learning enthusiastic is not very high.

When they learn online, they just finish the most basic tasks and don't spend time doing further study. About the tests provided to help check if they have mastered the knowledge point, they pay much more attention to the test scores than whether they have mastered the knowledge itself. In contrast, some of excellent students would make use of the advantage of repetition to grasp confusing points or get a higher score by way of retaking the tests to perform better to cover the lower score. Therefore, we believe that the teaching model of the flipped classroom provides the conditions for repetition, but it is not certain to help students with learning difficulties to keep up with learning pace. In this condition learning motivation is a more important factor. If students lack intrinsic learning motivation, the advantage of repeating of flipped classroom can't do more.

5.2 Implications

(1) **Strengthen supervision and guiding role of teachers and parents in order to take advantages of flipped classroom better**

The model of flipped classroom has given students a lot of free space, but self-control and learning strategies of primary students are not yet mature, and therefore they still need teachers and parents guide and monitor them.

For example, teachers can arrange some individualized learning tasks:

- Ask some students repeat watching the online learning resources;
- Take notes as their own needs and reward excellent students in note taking;
- In every face-to-face, students need to ask some questions they do not understand in the process of online learning.

Parents can also do something to help improve children's learning effects. They can help teachers monitor if children finish their individualized tasks and make contact with teachers.

(2) **Teachers should guide students to form their own learning strategies, and make a positive impact on students using their own teaching strategies**

Teachers should encourage students to form their own learning strategies in flipped classroom model, such as teachers should guide students to take notes according to their learning needs. In online learning, teachers guide students to write down knowledge points which are helpful to themselves and teachers will give students some incentives based on certain criteria.

In addition to proper guidance, teachers can also design more extensive teaching activities, and use their own teaching strategies to make an impact on students and take better advantage of flipped classroom.

As said previously, flipped classroom has freed teachers from constant speaking and explaining knowledge, so teachers can make better use of classroom time to use some teaching strategies such as teamwork and language applications, allowing students to collaborate, to express, to perform, to show, which must be a positive stimulus for students learning English. English learning is a process of long-term accumulation. As for the primary students, their strategy system is still not mature and teachers need to conduct and give suggestions to them, which will be an important step towards the future growth of the students.

Flipped classroom can bring surprises.

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Dealing with Ethical Issues in MOOC Design and Delivery: A Case Study

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Abstract. This case study provides a contextualized description of the various ethical issues faced by an instructional designer in the design and delivery of a MOOC. The defined characteristics of MOOCs in general (e.g., massive enrollment, open access, diverse student population) and the uniqueness of specific cases require a set of ethical decisions to be made for dealing with issues such as bias, fairness, copyright, and disruptions. Those decisions, along with their rationale and effects are elaborated and discussed in this study from the aspects of theoretical assumptions, pragmatic considerations, and empirical evidence. Based on the case study findings, this paper concludes with a list of informed advices and learned lessons to guide instructional designers and instructors to deal with similar ethical issues in future MOOCs.

Keywords: MOOC · Ethics · Bias · Fairness · Copyright · Classroom management · Instructional design

1 Introduction

While ethics should be emphasized in all forms of education regardless of their formats and contexts [1, 2], the defining characteristics of MOOCs such as massive enrollment, open access, and limited instructor intervention have presented ethical issues and problems unique to the MOOC context that merit special attention from instructional designers and instructors. Insufficient treatment of these ethical issues can disrupt teaching and learning in a MOOC, and also damage the reputation of the offering institute.

To further our understanding of ethical considerations in MOOC design and delivery, this study presents a case study of a MOOC designed and written by two of the authors. In this case study, we provide contextualized descriptions of the various ethical issues we have encountered during different phases of our MOOC creation, as well as the decisions we made to deal with those issues. The rationale behind those ethical decisions and their effects in the MOOC are elaborated and discussed from the

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aspects of theoretical assumptions, pragmatic considerations, and empirical evidence. Based on the case study findings, we present pragmatic principles for dealing with ethical faced by MOOC designers and instructors at the end of this article.

1.1 Outline for the Case Study

Kahn (2005) has identified several ethical issues that need to be considered and dealt with carefully when designing e-learning programs, including political influence, bias, diversity, online etiquette, and legal issues. We have encountered those ethical issues in our MOOC design and delivery, and will discuss them in this case study in the context of the five common phases of MOOC creation: planning, design, development, delivery, and evaluation. The focus of each section is provided in the list below. In this study, we will provide details about each potential issue by sharing our experiences and rationale for how we dealt with each one.

- Planning: Dealing with bias
- Design: Dealing with fairness
- Development: Dealing with copyright
- Delivery: Dealing with disruption
- Evaluation: Effects
- Conclusion: Issues, strategies, and factors.

1.2 Overview of the MOOC

The MOOC described in this study is "Energy, the Environment, and Our Future" (EEOF) (https://www.coursera.org/course/energy), one of the first five MOOCs offered shortly after partnering with Coursera by the Pennsylvania State University (Penn State). EEOF is an introductory course with the overall objective to present students with the essential, objective information on the past, present and possible futures of human energy use and how these uses affect the Earth we live on, including science, engineering, economics and ethics. To meet the overall goals of the course, it covers topics that are sometimes considered controversial in certain circles. For example, although human causation of global warming is not scientifically controversial, the subject is under continual political debate in the United States, and has become a partisan issue influenced by various groups including fossil fuels lobbyists, Evangelical communities, and environmentalists [3, 4].

A total of 44801 students from around the world signed up for the MOOC, and 22128 students were active in the course, with nearly 10 % of those earning one of the two available Statements of Accomplishment certificates. EEOF also engaged a team of five Teaching Assistants (TAs) to moderate the discussion forums and online learning activities. Figure 1 shows a typical page from the MOOC.

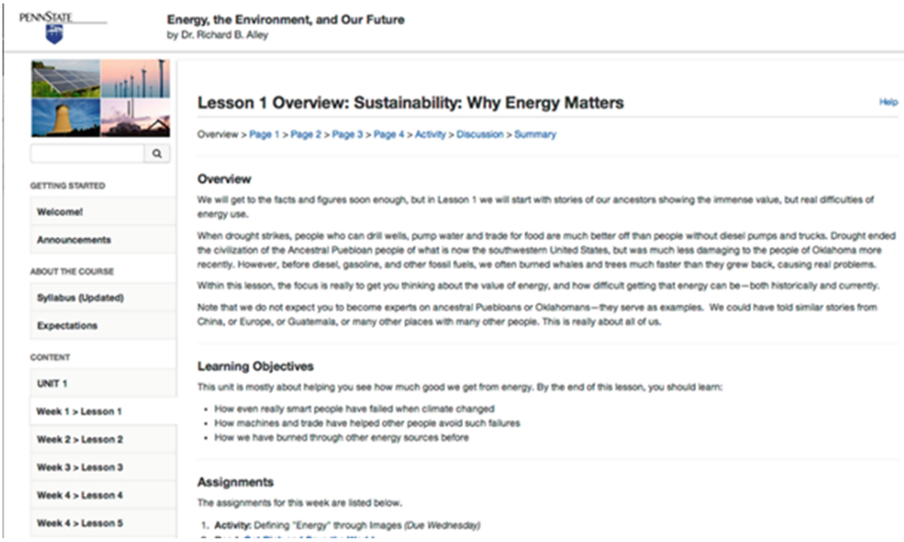

Fig. 1. The lesson one overview page of EEOF

2 Planning: Dealing with Bias

During our discussions throughout the planning, design and development phases of the MOOC, we identified three main issues that we knew would need to be addressed in order to limit bias in the course, and prevent bias from impacting the students' learning and damaging the reputations of Penn State courses. The first issue was how to keep students focused on the scholarship rather than on partisan politics or particular religious beliefs. The second issue was how to maintain civility when opinions differed wildly. The third issue was how to deal with attempts by "Internet Trolls" to derail the flow of the course for their own purposes. We employed a number of different strategies to accomplish our goals. In this section, we will detail the strategies we used to avoid most problems related to bias and to alleviate the few problems that did arise despite our efforts.

One of the first decisions we made was that the course content should focus on science and impartial scholarship only, not politics, not religion, not public opinion, and not personal opinions. This did not mean avoiding issues such as economics, ethics, or unequal impacts of climate change on different groups of people; it did mean that we addressed such issues from the solid, assessed scholarship of the most impartial sources. Furthermore, we wanted students to rely on scholarship while completing their activities and sharing their thoughts in the discussion forums. The strategy that we used to maintain impartiality was to either select sources or resources for materials developed by non-partisan groups and governmental agencies, or develop the materials ourselves based on such sources. We leaned heavily on the assessed science, such as publications of the U.S. National Academy of Sciences. We avoided materials from think-tanks even though some free-access, interesting materials and activities are available. In addition to limiting bias in the materials, we also wanted to limit bias in how we taught the MOOC. The strategy was to be extremely careful about not telling students what to believe or how to think, or even presenting our own opinions in the text. We wanted the students to make up their own minds based on the science and their own research. We repeated this mantra throughout the course and in communications with students.

Finally, we also wanted to make sure that the content our students shared with each other was also bias-free. To fulfil such purpose, we employed three interrelated strategies: First, we provided students with a combination of regular reminders in our weekly email communications and announcements. Second, we added brief notes to each assignment with instructive reminders for students to keep their answers grounded in the science presented in the lesson or other reputable non-partisan resources instead of their personal opinion. Third, we instructed our teaching assistants (TAs) to comment on student discussion forum posts when necessary. TAs were instructed to read over as many posts as they could each day, and then as gently and professionally as possible remind students to stay grounded in science.

3 Design: Dealing with Fairness

We focused on fairness at every stage of the MOOC design and development process, from planning through delivery, but especially in the design stage. Designing a course for thousands of people from one country is a challenge. Designing a course for tens of thousands of people from countries in every corner of the world is a bigger challenge. As shown on the map (Fig. 2), we had students from every continent on Earth except Antarctica, and making sure that a course is fair to each enrolled student can seem impossible at times. We have identified several issues related to fairness, including: balance between information on the U.S. and other countries, non-native speakers of English, measurement system and time zone differences, and access to high-speed internet.

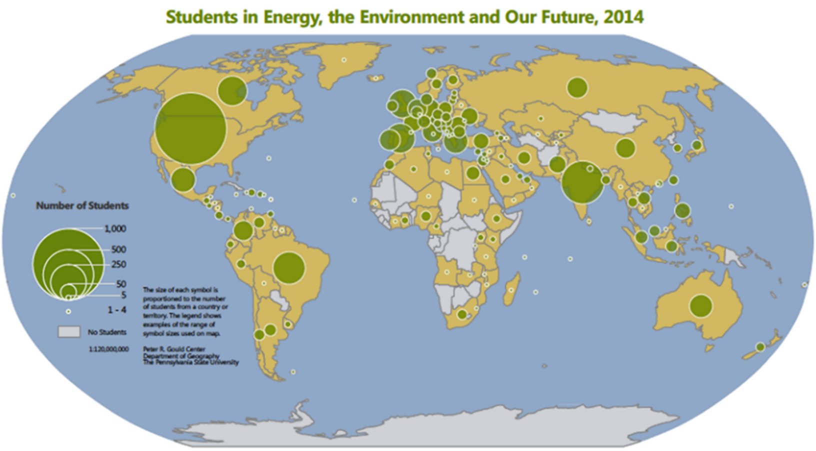

Fig. 2. Student distribution of the EEOF MOOC

The large and diverse international student population in the MOOC made it inappropriate for us to teach a completely U.S.-centric MOOC. However, a strong U.S. presence among students and the importance of the U.S. in energy and climate all favored much focus on the U.S. We knew that we could not possibly create a course that provides customized content specifically designed for individual students and their localized contexts. Our challenge was how to internationalize the course without writing dozens of versions of the content. Our solution was to draw on the expertise of the students, by writing discussion questions and activities that encourage students to explore the content in their own countries and share that information with their peers.

For example, we arranged for students to discuss the content in their own languages if they chose to do so. To accommodate this option, we provided opportunities for students to talk about the issues with their colinguals by setting up what we called *Birds of a Feather* forums. Students could use these forums to self-organize into groups based on their location or language choices. We created forums for each continent and for countries with large enrollments initially, but we also encouraged students to request new forums if the existing ones were insufficient. Interestingly, in addition to students' requests for new forums based on geographic locations, we also received a request to create a series of forums for educators to share ideas for teaching the course content in their own education settings, from elementary school through college.

The U.S. is large enough and sometimes insular enough that U.S. students often expect a course to use imperial measurement system (feet, pounds, Fahrenheit degrees) and U.S. time zones (often Eastern Standard Time). However, when we researched MOOCs we found several blogs mentioning that the use of these U.S. standards can cause great frustration to an international student population. As a result, we decided to set all of the assignment due times to Greenwich Mean Time (GMT) instead of Eastern Standard Time (EST), and present measurement statistics in our content in both imperial and metric format. This decision proved to be quite popular with our MOOC students, as we received several "thank you" notes from students posting in the discussion forums and on the Facebook pages.

Sometimes fairness means finding alternatives for students living in places that lack resources such as dependable electricity or internet connections. To ensure students with slower internet would have the same learning experience, we made all the videos (84 in total) available to be downloaded and watched offline at the student's convenience. When we realized that even these accommodations might not level the playing field for all of our potential students, we decided to design the assessment of the MOOC to be based on the textual content only and not include the video content in the quizzes. The videos added both interest and value to the textual content, but we made it clear to students that if watching video was problematic for them, they would not be penalized for it in the assessment.

4 Development: Dealing with Copyright

Copyright issues must be considered early and often by those developing MOOCs (or any other public materials, for that matter). This includes not only about how to protect their own copyrighted material, but also how to use materials owned by others in a course that may reach tens of thousands and possibly even hundreds of thousands of people. There are a number of strategies that can be employed to legally use content and resources developed by others in a MOOC. We used several of them for our MOOC, and will discuss a few in this section, including writing materials from scratch, linking to instead of embedding content, using Creative Common works, and partnering with copyright owners to create a win-win collaboration.

While we could have requested our MOOC students to buy a text book named *Earth: The Operators' Manual (ETOM)* that was written by the course instructor, we chose not to do so and decided to make all instructional materials freely available. So, we wrote entirely new materials for the MOOC, updated, customized to the purpose, and provided to the students at no charge and with no prior copyright restrictions. Because the content of the MOOC was close to the ETOM textbook, we were able to use several activities from its website (As shown in Fig. 3). Instead of embedding the activities in Coursera platform, we decided to link to them to ensure our students knew who developed and owned the materials that they were using. This resulted in a large number of hits for the ETOM website (an increase by 335 % in just two weeks) as well as their Facebook page.

Requesting permission to use materials owned by someone else can take a lot of time and can cost a lot of money, depending on the materials and the planned use. To avoid the need to perform copyright clearance, we decided to use only materials in Public Domain or Creative Commons Licensed works. Creative Commons (http://creativecommons.org) is a nonprofit organization that seeks to aid the sharing of knowledge and creativity by providing legal and technical infrastructure. Most of the licenses allow use and even derivatives of the work, but generally stop short of allowing others to profit from their endeavors. Because of this, we did not participate in the Coursera Signature Track program, which provides paid certificates to the students who completed the MOOC, potentially making money for the university.

Additionally, we made great use of the educational materials that were produced through the ETOM project. The three-hour PBS mini-series were broken into 3–9 min

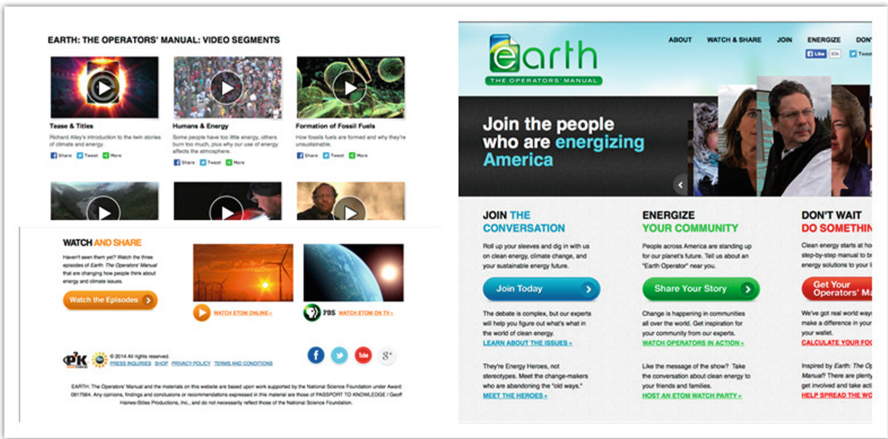

Fig. 3. The website of earth: the operators' manual project

videos and placed on YouTube. Geoffrey Haines-Stiles and Erna Akuginow, Director and Producer of the PBS mini-series, provided essential help in making the videos available in alternate ways. The numerous students who used the resources also visited the ETOM web site, and have contributed to the educational goals of the project and its National Science Foundation funding. We believe such collaboration was a win-win. We were able to enhance the student experience with beautifully produced materials, and the reach of the ETOM website and Facebook pages was greatly extended.

5 Delivery: Dealing with Disruption

From years of experience reading and contributing to environmental blogs, we anticipated that a few “Internet trolls” and other oddities from the ends of the Internet including “one-issue wonks” would enroll in our MOOC and cause disruption. The few “trolls” in our MOOC treated the targeted discussion forums much like any general online forum, “trolling” their classmates with inappropriate comments with the deliberate intent of provoking readers into an emotional response or of otherwise disrupting normal on-topic discussion. Wonks in our MOOC inadvertently caused disruption by monopolizing conversations and not respecting individuals who supported other sides of an issue, such as insisting that fossil fuels solve all the energy problems, or promoting nuclear energy as the only solution while dismissing all other renewable energy sources.

To be able to deal with disruptions, we first needed to find them. By the close of the MOOC, we had over 25,000 threads and almost 56,000 posts. We decided on a two-pronged approach, relying on the students and on our teaching assistants. Students were provided with ways to “flag” inappropriate content, and reminded of the options and procedures. Some flagging proved to be acceptable differences of opinion. One person who repeatedly flagged others in a discussion proved to be a one-issue wonk posting anonymously, who ultimately was blocked after failing to respond to our communications. To help this community monitoring by students, we recruited and trained four volunteer TAs to provide online classroom management for the instructors. This turned out to be another win-win: the TAs gained valuable experience for facilitating the MOOC, and we gained indispensable help for running the course.

In the end, we ended up blocking only six people, in fairly cut-and-dried cases. In one extreme case, the discussion thread revolved around overpopulation, a student told a person who was trying to have an intelligent conversation to “*kill yourself if you are so worried about overpopulation because that would be one less person on the Earth”*. This post was clearly beyond the pale, forcing our decision to block the student from the MOOC. The other individuals we blocked were just as disruptive in different ways: one person was spreading misinformation, deliberately misquoting and misattributing “facts”; another was condescending and just plain mean to other students; some hijacked conversations in the discussion forums without actually participating in the course; one even joked about how long it might take before he was kicked out of this MOOC.

Blocking the six individuals made the learning experience much better for the other 22,000 plus people who were actively engaged in the course. The transformation of the

MOOC's Discussion Forums was amazing to watch. Early negativity in some forums, with complaints and threats to drop out, quickly switched to a consistently and broadly supportive and engaging environment for learning. We received many "Thank You" comments and a few "It's about time" comments from students. In the end, we were glad we took the time to look into each complaint individually, and made judgment calls based on facts and clearly communicated expectations.

6 Evaluation: Effects

In the post-course survey, we asked students to rate their learning experience in the Energy MOOC, and a total of 953 students participated in the survey. The overall learning experience was rated as quite positive, with 51 % of students strongly agreeing and 40 % agreeing that the course has met their expectations. About 87 % of students felt that they have achieved their personal goals for the course (44 % strongly agree and 43 % agree), and 89 % of students would recommend the course to their friends (57 % strongly agree and 32 % agree). More specifically, the overwhelming majority of students agreed that the course content was presented in a factual manner, with 64 % and 33 % of students rating the factual accuracy of course content excellent and good respectively. Students' MOOC learning experiences with the assessment activities and discussion forums were also positive, evidenced in the 82 % and 77 % favorable ratings for those two aspects in the course. In the end, a total of 2165 students completed the MOOC, with 1146 earning the Statement of Accomplishment and 1208 earning the Statement of Accomplishment with Distinction. The completion rate is 9.7 %, which is higher than the other Penn State MOOCs, whose completion rates are around 8 %.

Our efforts to make the MOOC unbiased have been recognized by the students, as several students mentioned in the post-course survey that they felt the course content was "factual", "balanced", and "no-nonsense", and they liked how different perspectives were included. For example, one student liked the course for being "not preachy" and "full of facts and examples". Another student commented, "It is unbiased approach, not telling me what to do, but giving me direction and tools to find out the facts for myself… a great way to learn." Students also liked how the course activities and assignments were made relevant to their own local contexts rather than U.S.-centric. One student identified the one thing he liked most about the course to be "researching how what I have learned is relevant in my immediate environment". Another student expressed similar viewpoint and pointed out that he enjoyed the localized activities in the MOOC such as posting energy resources of his own area, saying, "because of which I gained a lot of knowledge about energy resources in my country".

Students in general enjoyed participating in the course discussion and felt they benefited from the exchange of ideas, new insights from people in other countries, and a sense of world community. For example, one student said he liked the discussion forums for "the diversity of different minds offering different ideas from individual perspectives, sometimes clashing". Other students have identified the benefits of engaging with a large international student population, and made comments including: "I liked access to the discussion boards and especially because the participants were from all over the world". "Different points of view that helped me to realize and understand climate situation in many other countries".

However, many students also reported unpleasant experiences in the discussion forums and suggested more moderation and earlier intervention from the teaching staff. Several complaints are about the condescending or sarcastic tones of fellow students. One student summarized such feeling and said, "(I do not like) the sarcastic attitudes of fellow students expressed in forum posts - even when I agreed with them! Stifled any desire I originally had to share my perspectives on ANYTHING". A few students even described their experiences in the Discussion Forums as intimidating. For instance, one student commented:

> "*I felt bullied on the discussion board. It was intimidating. I titled a post, Put Iceland on Your Bucket List, and got lambasted about flying. The responder never explained the amount of CO2 used in travel, just talked about dead babies in my bucket. Very creepy and sort of scary!*"

Comments like this have convinced us that it was the right decision to block those Internet trolls from the discussion forums, and we only wish we could have done it earlier. We note that these comments were primarily in the early part of the course, before blocking the disruptive students.

7 Concluding Thoughts

In this study, we have tried to share the challenges we experienced in a MOOC on a broad topic that generates extensive public arguments. We focused on common problems that anyone designing or developing a MOOC on a controversial subject might face. We believe that the lessons we learned can be applied to a MOOC on any topic, whether it is controversial or not. (We know of a case in which nasty insults were sent to students in an art MOOC by an Internet troll in the class who did not like their drawings; somehow, the Internet seems to bring out the worst in a very small but often very intrusive minority of the population.) MOOC designers, like designers of any other course, face ethical issues continually, but the size and public nature make the ethical issues more visible in MOOCs. We have discussed some of these ethical issues here in relation to bias, fairness, copyright and disruption in our MOOC.

Our first advice for dealing with ethical issues in a MOOC is to trust your instincts but do your homework. The subject of any MOOC is likely to overlap with active blogs and other forums on the broader Internet; the issues arising in those can be expected in the MOOC, allowing the instructional team to be proactive. In our case, a few of the same people who frequently cause problems on environmental blogs also caused issues in the MOOC. To them, the MOOC was just another public forum to exploit for their own purposes. So, setting expectations immediately for acceptable behavior in the Discussion Forums is extremely important. When everyone knows the rules, no one can claim that the rules were unfair or that they were singled out because of their beliefs, whether those beliefs are political or in some cases religious. Each person in the course is treated as equally as possible.

We also advise careful consideration of expectations for students, and a multi-tiered approach. The remarkable diversity of students in a MOOC means that professionals and highly dedicated amateurs are likely to be interacting with rank novices, complicated by a wide range of language skills and Internet connection speeds. Set the expectations too low and many students with much to offer will be lost; set the expectations too high, and many students who need the course most may be alienated. We ended up reevaluating our requirements the first week of class, and lowered the initial standards to something more attainable for a larger number of people. We believed it was the right thing to do after hearing complaints from many students. We wanted to make sure that the students knew we were hearing them, and wanted them to feel that we cared about what they thought and would be responsive to their needs.

We note, however, that there were negative posts. No matter how hard you try, you simply cannot make everyone happy. We have been telling teaching assistants for years, long before our entry into MOOCs, that the online learning environment seems to empower students to complain more frequently and less politely than the in-person environment. So, don’t take the negative comments personally.

Our last piece of advice is to celebrate the size and diversity of the MOOC, without trying heroically to control every little thing. We were fortunate to have an instructional team, but there were still tens of thousands of students to a few instructors. As a result, we trusted the students, and they responded by stepping into the open space. They helped each other when they needed to and kept each other in line, too. Early in our MOOC, the instructional team would jump in immediately when a student had a question or a problem, but we quickly learned that by waiting a few hours, one of the other students in the course was likely to step in and help their classmate. Generally, they provided the correct information and supported each other. By watching for un-met requests or inaccurate information, and by thanking the active students, we could limit our workload and help grow the community.

Dealing with ethical issues, whether it is the ethics of the individuals writing and developing the MOOC or the ethics of the individuals participating in the MOOC, can be complicated with so many people to consider. After all is said and done, all it takes to be successful at teaching a MOOC as ethically as possible is a lot of planning and communication between the instructors and learning designers about potential issues during design and development phases, and then a good deal of open-mindedness, flexibility and follow-through during the delivery stage of the MOOC.

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Research on How to Use OUC Cloud Classroom to Assist Education Development in Tibet

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Abstract. In response to the educational needs in promoting development in Tibet, this paper proposes a set of educational path milestones to assist development in Tibet, including essential factors such as the building of a blended teaching environment, organization of teaching teams, development of learning contents and resources, and collection of educational tools. With the completion of the primary path structure, teaching will be carried out in three stages: work mobilization, teacher training, and classroom teaching. The effectiveness of the path has been proven in practice. The cloud classroom system of the Open University of China (OUC) offers stable performance with smooth video communication. The teaching team is diversified in composition with a rational division of labor and close coordination. The learning contents are cutting-edge in subject selection, easily arousing the interest of teachers and students and encouraging participation in the training and giving easy access to the rich learning contents. The teaching tools are guaranteed to be in place.

Keywords: Assistance to Tibet · Education · Teacher training · Digital divide · Cloud classroom

1 Introduction

It has been a significant strategic decision of the CPC Central Committee and the State Council to promote educational development in Tibet for years. It is a major political measure designed to fundamentally solve the problem of development and stability in Tibet, and to build a united, affluent, culturally and ethnically advanced and harmonious socialist society in Tibet Autonomous Region. It is an effective way to transform population resources into labour resources in the shortest possible time and create a real productive force that can realize greater, faster, better, and more economical development of socio-economy in Tibet. Educational assistance to Tibet is a political task of far-reaching strategic significance and a specific job of practical significance. Mr. Zhou, one of the authors of this paper, has served in Chamdo Education (Sports) Bureau in Tibet Autonomous Region on a three-year assignment to assist Tibet.

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"Educational Balance" means building a stable, coordinated, and orderly relation among the different parts and essential elements within the educational system so as to achieve a relative balance. The internal equilibrium refers to the balance of quality and effect, and velocity and scale, while the external equilibrium refers to the balance of structure and layout [1].

Key factors influencing the balanced development of education are related to the unbalanced allocation of educational resources, including hardware and software resources, as well as teacher resources, which are both resource allocation issues at their core. Teachers are the major resource in which there is a lack of balanced allocation. For a long time, Tibet Autonomous Region has faced this difficulty. Improving resource allocation so as to achieve a more balanced teacher allocation condition and in order to remove this bottleneck restricting the balanced development of education in Tibet is a necessity.

With the support of modern information technology, great changes have taken place in the forms and application models of educational resources. It is the same with the position, role, and form of teachers. In a sense, "Internet + education" follows the model of the world wide web in optimizing and integrating educational resource allocation, in restructuring educational resource allocation, in changing traditional educational forms, and in shaping a new type of educational development based on the Internet infrastructure and supported by modern and new technological tools.

To narrow the digital divide between China's Western and Eastern areas, to improve the digitization of border areas, especially that in the OUC Xinjang Branch and Xinjiang Corps Branch, and Tibet School, and to support the development of educational undertakings in Xinjiang and Tibet, the OUC initiated the construction of cloud classrooms at the beginning of 2013. The cloud classroom project embodies an important measure of the OUC in its exploration of "Internet + education".

The focus of this research is to explore the digitization environment and its ability to support resource sharing and balanced educational development by relying on the OUC cloud classroom system. It aims to build new educational strategies in offering assistance to Tibet, to change the existing poor and weak educational foundation conditions, to promote the balanced development of education, and to improve overall education quality in Tibet.

2 Path Building

It has become necessary to build a brand new teaching model in order to bring the quality educational resources of big cities like Beijing to remote areas such as Tibet. This is the goal of combining both online and offline teaching in a blended system, which still includes the basic elements of teachers, students, contents, and media. The teachers are made up of teams distributed in different areas instead of single individuals; teaching contents can be freely chosen according to current development needs, and are no longer restricted to the knowledge scope of local teachers; teaching media consists of online classroom systems to achieve two-way distance interaction and cognitive tools to support the learning of relevant contents instead of one single book or one multi-media classroom.

With the consideration of the OUC Research and Development Centre for Digital Learning team and in light of the practical needs of Chamdo, Tibet, the OUC cloud classroom system and Moodle online teaching platform have been chosen for the blended environment. “3D Printing Technology and Its Teaching Application” has been chosen for the learning contents. The 3D printing lab and 3D printer are utilized as teaching tools. The teaching team is made up of experts in educational technology, experts in the discipline of information technology, 3D model designers, 3D printer engineers, and teachers of the discipline of information technology in Tibet. Mr. Zhou has been sent to Tibet to support the project’s coordination; and junior middle school students of the 3D Printing Society from Beijing Jingshan School and students from Tibet have been chosen to be interactive learning partners.

2.1 Building the Blended Teaching Environment

The blended environment consists of the OUC cloud classroom system and online teaching platform.

Cloud Classroom System. The cloud classroom system is a classroom network covering cloud classrooms throughout China, private and universal networks connecting the cloud classrooms, as well as control centres at all levels, which’s structure is shown as Fig. 1. The core is comprised of the various control centres, the transmission line is made up of the computer networks, and the basic nodes are the cloud classrooms. The cloud classroom is a digital classroom that can provide the students and teachers with a comprehensive learning experience. It represents the advanced teaching equipment hardware which integrates distance video frequencies, interactive screens, cloud video playback, e-schoolbags, the multiple software applications and learning resources of online student space, online courses, online teaching teams, online learning assessments, online teaching management, and online learner support, as well as such functions as teaching, assessment, management, support, and research. The cloud classroom system can support the teachers and students in distance live teaching, live playback of courses, distance class observation and teaching discussion, distance interview and defense, teaching management conferences, and other typical business [5].

From February 2013 to December 2015, 297 cloud classrooms and 21 control centres were built in China, covering 22 OUC branches and serving thousands of teachers and students. Of these, there was one “cloud classroom” branch control centre in Tibet and a cloud classroom in each of the study centres in Lhasa, Shannan, Xigaze, Nyingchi, and Chamdo built to assist in the development of Tibet.

The cloud classroom in Beijing is connected to that in Chamdo via the control centres of the cloud classroom system, laying a foundation for Beijing-Chamdo live interactive teaching.

Online Teaching Platform. The online teaching platform is built with the Open Source Moodle Platform to release course contents and show student work. Several modules are set up in the online i-3D printing lab. They provide a large amount of

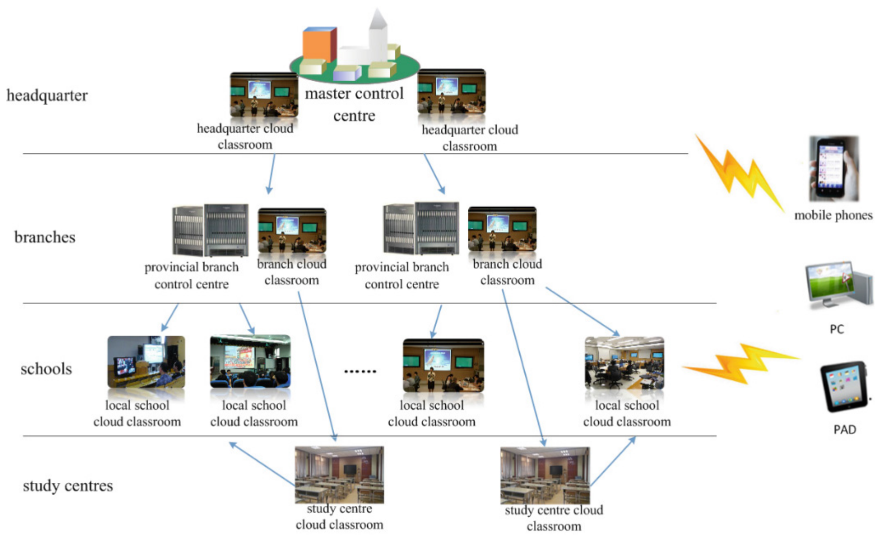

Fig. 1. Structure of the cloud classroom system

information relevant to 3D printing and live reports on 3D printing teaching. At the same time, the registered users of the website are also offered the interactive 3D printing model platform for learning exchange and a download model for an even greater number of learning resources.

2.2 Building the Teaching Team

The teaching team is made up of the project coordinator, educational technology experts, information technology experts, 3D model designers, 3D printer engineers, and information technology teachers in Tibet. Among them, the coordinator takes responsibility for contacting the teachers in Beijing and Tibet so as to arrange for various teaching and exchange activities; the educational technology experts are in charge of building the blended teaching environment to complete course development with 3D model designers and printer engineers; information technology experts fulfill teacher training and distance teaching with 3D model designers and printer engineers; information technology allows teachers based in Tibet to receive the dual benefits of both receiving training and offering live teaching to the Tibetan students.

2.3 Development of Learning Contents and Resources

The selection of “3D printing technology” as the topic for educational assistance offered to Tibet is based on of the following three considerations. Firstly, 3D printing is an innovative achievement capable of revolutionary influence over the traditional manufacturing industry, and is regarded as "a significant production tool of the third industrial revolution". Offering 3D printing technology training to middle and primary school teachers in Chamdo, Tibet, makes the latest cutting-edge technology accessible in the ethnic and remote areas and narrows the digital divide. Secondly, 3D printing technology is of particular significant value to education. It can create more real and reliable exploration opportunities for things, and such opportunities are hard to get for these schools. Lastly, the OUC Research and Development Centre for Digital Learning can be said to have made full knowledge preparations since it launched the exploration and application of 3D printing technology at the beginning of 2013 and the establishment of the i-3D printing lab.

In course resource development, the syllabus has been made up for 3D printing as shown in Table 1. Accordingly, the teaching team has compiled written materials for teaching, developed online courses, and collected and produced about 20 micro classes and over 500 model material resources.

Table 1. Syllabus for 3D printing

Elementary 3D Printing. Understand the background of 3D printing technology —— the third industrial revolution and its major features; grasp the meaning and basic principles of 3D printing technology; know the application fields and the industrial development of 3D printing technology focusing on the application of 3D printing technology in the field of education; learn the structure, material type, and manual of the 3D printer.
3D Printer Operation. Learn the principles of 3D printing technology; master the structural principles of the 3D printer; know and grasp the assembly and maintenance of the 3D printer; understand the structure of the 3D printer (for industrial use); to learn the 3D printer's printing of human body, building, machine and model; master the increase of 3D printing data.
3D Modeling Software. The existing 3D model; the 2D-to-3D model (Part One and Part Two); Boolean operation and lofting; modifying graphics (Part One and Part Two); polygonal modeling; scene merging; material and mapping; effect drawing modeling; radiosity; model derivation and modification.

2.4 Collecting Teaching Tools

The OUC Research and Development Centre for Digital Learning seized the opportunity of building "i-3D Printing Lab for Community Education" to work on the design and construction of the 3D printing experience room, including the 3D printing experience zone, 3D scanning zone, guide zone, design zone, and works display zone. In the end, the room was completed in the summer of 2014 and put to use in teaching, which supports course research and development and live demonstrations for teaching broadcast to Tibet.

Though it is impossible to build a fully functional 3D experience room for the teachers and students in Tibet due to restricted conditions, they should, at least, have a 3D printer.

Luckily, the influence of the OUC Research and Development Centre for Digital Learning has made this a reality. AOD 3D Printing Co., Ltd of Qingdao and the Centre work together in popularizing the use of 3D printers in middle and primary schools. The company donates printers to schools, while the Centre helps the local middle and primary schools to offer 3D printing courses.

3 Teaching Implementation

3.1 First Stage: Mobilization

On December 4, 2013, the Tibet Assistance Work Group held the first mobilization meeting via the OUC cloud classroom. The bilateral Beijing-Tibet meeting for launch and mobilization was held via the cloud classroom. The tasks were defined, the team members were chosen, and ideas on the work plan were exchanged.

During the entire course of the meeting, the video feed was clear, the voice flow was smooth. It was as if the people were talking face to face with each other. The first use of the cloud classroom left the teaching team with a positive impression.

3.2 Second Stage: Teacher Training

From July to December 2014, the Beijing team gave four training sessions to teachers from Tibet via the OUC cloud classroom. They carefully demonstrated the entire process of modeling, from the virtual digital model of 3D printing to 3D solid modeling, covering “3D Printing Technology and Its Application in Education”, “Understanding and Operation of 3D Modeling Software”, “3D MAX Teaching and Creation Example”, and “Use and Learning of Printer Bundled Software”.

The OUC Research and Development Centre for Digital Learning has brought into play its advantage in “technology integration and application”, and integrated the 3D virtual studio based on the cloud classroom system, as shown in Figs. 2, 3, 4 and 5.

With the help of the 3D virtual studio, the Tibetan teachers can see not only a picture of the training teacher, but also the PPT presentation and demonstration printer operation. Furthermore, the operation of the virtual studio presentation highlights pictures on which the students can focus in order to have a better grasp of the learning contents. Additionally, the cloud classroom also offers the additional function of playback. Upon the completion of each training session, the presentation is recorded and released to the online teaching platform for the trainees of Chamdo, Tibet to re-play on demand.

Some problems were encountered in the latter training sessions. For example, the originally planned 3D MAX software teaching operation was replaced with Sketchup software due to problems in 3D software installation in Chamdo during the second training session; also, the third training session was delayed for 30 min because network connection problems delayed the linking of the Beijing and Chamdo cloud classrooms.

Cloud Classroom of Nonintegrated 3D Virtual Studio

Fig. 2. Standard teaching scene of cloud classroom

Cloud Classroom of Integrated 3D Virtual Studio

Fig. 3. Virtual studio shot of cloud classroom

Fig. 4. Virtual panorama studio of cloud classroom

Fig. 5. Virtual multi-screen switch studio of cloud classroom

After the completion of the fourth training session, the trainees designed the Eight Auspicious Wealth Vase in line with local cultural characteristics by utilizing the 3D modeling technology that they had learned, and had it printed in Beijing, since the 3D printers had yet to be delivered to Tibet before the end of the training. The trainees also wrote down their impressions of the learning experience. The Tibetan learner Xiaobianbazeren said that the training teachers showed them a real 3D printer via online video at a time when 3D printing technology was relatively unheard of in Tibet. Moreover, he said that the presentation was carefully designed to immerse them in the structure and capabilities of a 3D printer. He also said it was possible for 3D printing technology to reconstruct 3D virtual objects. Tibet has been blessed with a rich artistic side and meaningful cultural background, but a number of concepts cannot be created due to limited resources. 3D technology has the power to make a 3D display of these art concepts. For example, some Tibetan cultural decorative drawings like the eight auspicious patterns can be displayed in a 3D manner, and Tibetan architecture with its peculiar features can also be reconstructed in a microscopic three dimensional scale. Zhang Junrui, an ethnically Han student, said online video learning not only shortened the distance between Chamdo in Tibet and Beijing, but also enhanced emotional ties and was a major forward-looking measure in the development of the digitization of basic education in terms of educational development in Chamdo.

Together, the four cloud classroom based training sessions showcased the capabilities for the stable operation of the interactive video function of the cloud classrooms with the simultaneous support of all kinds of equipment such as virtual studio system, 3D printer, computer, software, and more. Sufficient hardware and software are the necessary basic conditions for long term distance courses. Only under these aforementioned conditions can the students and teachers at both terminals of the distance education connection enjoy meaningful exchanges and communication.

3.3 Third Stage: Classroom Instruction

After receiving 3D printing training, the teachers in Tibet set out to give their students classroom instruction immediately.

In October 2014, the 3D Printing Society was established in Beijing Jingshan School with the support of the OUC Research and Development Centre for Digital Learning, and it was up to the team at the Centre to lead the 3D courses.

After one term of teaching, the teaching team has enriched the resources used in the 3D printing class, adding over 50 video resources in teaching, 3D publicity, and 3D printing creation; 800 material resources; and 7 software resources, including 3D online modeling software: www.3dtin.com/https://tinkercad.com and installation software Sketchup3Dmax MAYA CAD Solid works ……, as well as the complete class teaching design plan. Tibetan information technology teachers can teach their students with full confidence that they will be supported by these resources.

To study alone without friends around leads to less learning and more ignorance. To better integrate research on rural educational development and reform with simultaneous advancements in industrialization, urbanization, agricultural modernization, and digitalization, Point-to-point video interaction between teachers and students in Beijing and Tibet via cloud classrooms has been instituted to enrich the contents of project research, to enhance the cultural integration and ethnic unity among the students of both Han and Tibetan ethnic groups. Besides exchanges and discussions on 3D printing technology among the students, live hard-tipped pen calligraphy competition of Chinese and Tibetan writing was also held. The students of Chamdo Experimental Primary School performed the intangible cultural heritage Reba and Xuanzi dances and songs.

4 Conclusion

This paper proposes an educational path for assistance in the development of Tibet based on the national need for educational development for Tibetan assistance utilizing the OUC cloud classroom system. It includes such factors as the building of the blended teaching environment, the building of the teaching team, the development of learning contents and resources, and the gathering of teaching tools. The OUC cloud classroom system and Moodle online teaching platform were chosen for the blended environment; the "3D Printing Technology and Its Teaching Application" were chosen for learning contents; the 3D printing lab and 3D printer are needed as teaching tools; the teaching team is made up of experts in educational technology, experts in information technology, 3D model designers, 3D printer engineers, and teachers of the discipline of information technology in Tibet. It is up to Mr. Zhou, who has been sent for support on the Tibet side, to facilitate coordination. Junior middle school students of the 3D Printing Society from Beijing Jingshan School and students from Tibet have been chosen to be interactive learning partners.

With the completion of the initial phase of learning path construction, teaching was implemented in three stages, including work mobilization, teacher training, and classroom teaching. The effectiveness of the path has been proven in practice, which is embodied as follows: The OUC cloud classroom system offers stable performance with smooth video communication; the teaching team is diversified in composition with rational division of labor and close coordination; the learning contents are cutting-edge in subject selection, which encourages teachers and students to participate in the training with rich learning contents and easy access; and the teaching tools are guaranteed to be in place.

Generally speaking, the educational development path for Tibetan assistance based on the OUC cloud classroom system can be replicated for educational development in assistance to other border areas, taking the advanced educational technology and concepts to borders, remote areas, minority and poverty-stricken areas. Thus, information technology based teaching conditions can be greatly improved in Xinjiang, Qinghai, Tibet, Inner Mongolia, and other remote border areas in the west of China, and leapfrog development of digitalization teaching can be made in assisted schools, especially in farming and pastoral border areas. Hence, neither high mountains nor distant roads can block the access to quality education. The sons and daughters of all ethnic groups can gather in the cloud classroom anytime, anywhere to enjoy the happy opportunity for education.

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The Open Textbooks for Hong Kong: From Conceptualization to Implementation

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Abstract. As a specific type of open educational resources, open textbooks can be used as official textbooks for classroom-based teaching and learning in both universities and schools. The first official open textbook system just came into existence in Hong Kong although open textbooks have been adopted in North America for a decade. This paper describes the open textbook system for Hong Kong from its conceptualization to implementation. In this paper, the problems of traditional textbooks in Hong Kong that motivated the development of open textbooks are addressed. The development of this open textbook system is described, where the opportunities and challenges are discussed. Based on the lesson learned, an open textbook system should comprise four essential components, namely, a platform for operating open textbooks, a repository of open textbook contents, quality assurance mechanisms, and the continuous capacity building for users. In order for open textbooks to be sustained in the long term, public support should be garnered. Volunteer groups should be formed while continuous philantropic support should be solicited. From time to time, evaluation and reviews should be conducted for continuous improvement.

Keywords: Open textbook · Open educational resource · Open textbook system · Open license · E-Learning

1 Introduction

In the past two decades, open educational resources have evolved as a major source of educational materials for teaching and learning. They are "digitized materials offered freely and openly for educators, students, and self-learners to use and re-use for teaching, learning and research" [1]. They can be user-generated contents such as Wikipedia [2] and Wikibook [3], institution-led open courses such as Open Courseware [4], EdX [5] and Coursera [6], online repositories of learning materials and e-books such as Connexions [7], Open Access Textbooks [8] and Flat World Knowledge [9]. There are four categories of open educational resources, namely, open courseware, open online courses, open e-books, and open-source software and tools to support teaching and learning [10].

As a specific type of open educational resources, open textbooks are by nature open access e-books that can be used as official textbooks for classroom-based teaching and

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learning in universities and schools [11, 12]. The key difference is that the open textbooks adopt open licenses whilst the traditional textbooks do not. These open licenses allow users to reuse, revise, remix and redistribute. Widely adopted by many open textbook systems, Creative Commons offer different open license options, specifying whether the textbook contents can be revised or not, redistributed or not, shared alike or not, and for non-commercial or not [12–14].

Open textbooks are freely available for use and adaption. As the open licenses can allow users to revise and remix the contents, open textbooks can be freely customized to cater for individual learning needs. Invariably consisting of digital contents, open textbooks can be delivered in many formats, including web, e-reader, and printed formats. Multimedia elements and animated features can be included as appropriate, for example, audio and video clips for learning languages. When compared to other freely available online learning materials and objects in the Internet, open textbooks are self-contained e-books. They are well-organized and coherent in contents, and follow particular curricular guidelines and standards.

Inevitably, open textbooks have many advantages over the printed textbooks. In early 2000s, the ideas of open textbooks started to evolve, not only for combating the high price of textbooks but also for promoting knowledge creation and sharing. Open textbooks have been used in universities and schools in North America for more than a decade. Connexions [7], Open Access Textbooks [8] and Flat World Knowledge [9] are some well-known open textbook projects. Although the open textbooks are free of charge, they meet the necessary academic standards, for example, the open textbooks from the California Free Digital Textbooks Initiatives have met over 90 % of the required academic standards [15].

In Hong Kong, where almost all primary and secondary schools are still using the traditional printed textbooks for classroom-based teaching and learning, the issue of high price of textbooks and their associated learning materials has been perplexing the community for many years. In 2012, the author together with a number of academic peers at the Open University of Hong Kong formed a team to explore the possibility of developing open textbooks for Hong Kong [11–14, 16]. After several rounds of investigations and proof of concepts, the team successfully solicited a generous funding from the Hong Kong Jockey Club Charities Trust for developing the first official open textbook system in Hong Kong. It covers open textbooks for primary and secondary schools as well as universities and post-secondary institutions [17]. This paper describes the system, from conceptualization to implementation. It begins with stating the problems of printed textbooks that motivated the development of open textbooks. The development of this open textbook system is described, where the opportunities and challenges are discussed. The experience in implementing open textbooks for Hong Kong is shared from an insider's perspective.

The rest of this paper is structured as follows. Section 2 introduces the ideas of open textbooks and open licenses. Section 3 describes the first official open textbook system for Hong Kong, called the Open Textbooks for Hong Kong. Section 4 shares the experience in implementing the open textbook system. Section 5 concludes this paper with a discussion on how open textbooks can be sustained.

2 Open Textbooks and Open Licenses

With the advent of the Internet technologies, open educational resources are made available for sharing and adaptation. Through open licenses, the contributors of open educational resources grant users the rights to reuse, revise, remix and redistribute the resources. Users can freely use these resources, make any revision and improvement, and in turn, share the revised or remixed resources to others.

Open textbooks are essentially a specific type of open educational resources which can be used as official textbooks for classroom-based teaching and learning [10]. They are by nature e-books that can be characterized as follows. First, they are freely available for use, re-use and adaption. Second, they consist of digital contents which can be delivered in many formats, where multimedia and animated features can be included. Third, they are coherent in contents and are aligned to particular curricular guidelines and standards, and can be customized to meet individual learning needs. Fourth, the copyrights are governed by open licenses, such as Creative Commons which clearly defines a list of rights and permissions.

It has been an undeniable fact that online resources have been proliferating in an exponential scale. A vast amount of open educational resources are available from the Internet. In early years, these open educational resources were mainly for university or college studies. The resources were rather scattered and unorganized. As time went by, online platforms were developed for organizing these resources as a consistent whole. Wikipedia [2] and Wikibooks [3] are representative examples. Open e-books then evolved. They are diffusing to textbooks, not only for universities and colleges but also primary and secondary schools, for example, Connexions [7], Open Access Textbooks [8] and Flat World Knowledge [9].

In many prior studies, open textbooks offer many advantages over the traditional printed textbooks [11–13, 18–20]. First, they are freely available from the Internet. No copyright charge is required even the users choose to print them in hard copies. Second, without worrying about the copyright issues, they can be readily revised and customized to meet the individual learning needs. Third, the practice is conducive to knowledge creation and sharing. Fourth, as they are in electronic format that can be easily re-distributed over the Internet, subsequent revisions can be quickly deployed. Also, online and interactive learning objects, multimedia components and animated features can be easily incorporated.

Open licenses enable the contributors of open textbooks to grant users the rights to reuse, revise, remix and redistribute the textbook contents. Creative Commons define the open licenses for users of open textbooks. There are four essential attributes for open licenses, namely, attribution, non-commercial, no-derivatives, and share-alike [21]. Attribution means that users may copy, distribute, display and make derivative work if they give the author the credits. Non-commercial means that users may copy, distribute, display and make derivative work only for non-commercial purposes. No-derivatives means that users may copy, distribute and display but not make derivative work. Share-alike means that users may distribute derivative work under a license identical to the license that governs the original work.

Based on the different possible combinations of the four essential attributes, a total of six license types are derived. They represent six options of open licenses that suit different purposes and usages for the users. Table 1 list these open license options under Creative Commons.

Table 1. List of open license options under creative commons.

Codes	License types	Rights
BY	Attribution	Users can distribute, remix, tweak, and build upon the author's work as long as they credit the author for the original creation.
BY-SA	Attribution + Share-alike	Users can remix, tweak, and build upon the author's work even for commercial purposes, as long as they credit the author and license the new creations under identical terms.
BY-ND	Attribution + No-derivatives	Users are allowed for redistribution as long as it is passed along unchanged and in whole, with credit to the author.
BY-NC	Attribution + Non-commercial	Users can remix, tweak, and build upon the author's work non-commercially, and although the new work must also acknowledge the author and be non-commercial, they do not have to license the derivative work on the same terms.
BY-NC-SA	Attribution + Non-commercial + Share-alike	Users can remix, tweak, and build upon the author's work non-commercially, as long as they credit the author and license the new creations under the identical terms
BY-NC-ND	Attribution + Non-commercial + No-derivatives	User can download the author's work and share them with others as long as they credit the author, but they can't change them in any way or use them commercially

Source: Website of Creative Commons [21].

3 Open Textbooks for Hong Kong

This section describes the first official open textbook system or platform in Hong Kong, called the Open Textbooks for Hong Kong [17].

3.1 Background of the Project

In Hong Kong, the traditional printed textbooks are widely adopted in primary and secondary schools. The textbook publishers used to revise the textbook contents and raise the price every one or two years. Textbooks cannot be reused after one or two years because of the revisions, and students need to pay high costs for new textbooks. For many years, the issue of high price of textbooks and their associated learning materials has been perplexing the community.

In 2012, the author together with a number of academic peers at the Open University of Hong Kong initiated a project for developing open textbooks in Hong Kong [17]. With the funding support from the Hong Kong Jockey Club Charities Trust, the project commenced in 2013, and took three years to complete. It was formally launched in January 2016.

The project addressed a number of problem issues on the printed textbooks in Hong Kong, as listed below.

- The printed textbooks contents are rather static. They are costly to update, and become even more expensive when bundled with the associated learning materials such as multimedia components.
- The printed textbooks are not flexible enough to meet the specific learning needs because they cannot be customized for a variety of learning objectives and contexts in a timely manner.
- Curricular developments and reforms exerted extra pressure on publishers. Their conventional business model in publishing textbooks is unfavourable for meeting the modern demands of a more diverse curriculum and catering for mixed students' abilities and variable school preferences.
- The publishers are not willing to take full advantage of digital technology and put the learning materials online. They are wary of piracy and uncertain about copyright acquisition and protection.
- There is a lack of platforms for teachers to develop and share their developed teaching materials and resources with the peers.

The project attempted to address the problem issues by introducing a new approach to textbook development – developing open textbooks using open licenses. The target users are the teachers and students as well as the general public. The scope covers the primary and secondary schools, post-secondary institutions and universities. There are four components, namely, an online platform, a repository of textbook contents and the associated learning materials, quality assurance mechanisms, and the continuous capacity building for users [12, 22, 23]. They are described below.

3.2 Online Open Textbook Platform

An online platform is required to serve as the interfaces for users to access the open textbooks. Different from typical learning management systems [24, 25], the online platform serves at least three functions [22, 23]. First, it provides a repository for hosting the textbook contents for online accesses. Second, it allows users to select appropriate textbook contents and customize them to meet specific learning needs. A two-way interactive and iterative process is supported, for users to download, revise, remix and upload the revised or remixed contents. Third, although the online version of the textbooks may be sufficient for teaching and learning, online requests can be made to some printing houses for mass printing of the selected textbooks. Figure 1 shows the homepage of Open Textbooks for Hong Kong (2016).

The platform adopts a technical infrastructure comprising a contents server and a media server [16]. A learning management system and a content management system

Fig. 1. Homepage of the open textbooks for Hong Kong.

collaboratively operate on this infrastructure. Learning object database, user profile database and media repository database are accessed through a retrieval engine. Data are organized and formatted as XML so that various formats such as PDF, SCORM, e-Book and e-Pub are supported. A website is used to serve as the user interfaces for users to access the open textbooks through the Internet.

3.3 Open Textbook Contents and Learning Materials

A repository of textbook contents and learning materials is the core of an open textbook system. These contents and materials include the newly developed contents as well as the existing resources which are already available elsewhere for reuse and adaptation. According to Cheung et al. [12, 13], the following four strategies can be taken in developing the open textbook contents and learning materials:

- to aggregate and select relevant and usable open educational resources which may be scattered and unorganized;
- to borrow and adopt some existing readily available open e-books or materials under some open license schemes;
- to enlist the support of practitioners to cooperate and collectively develop the open textbook contents and learning materials;
- to deploy and recruit professional writers to create original textbook contents and learning materials; and

In the Open Textbooks for Hong Kong, a combination of the above strategies has been taken in preparing the open textbook contents and learning materials. The open textbooks are grouped under the following categories.

- *Open textbooks at primary and secondary education level.* Professional writers were recruited to create the original textbook contents and learning materials. Relevant and usable open educational resources were also adopted to enrich the contents. Figure 2 shows a list of Primary 3 English textbooks.
- *Open textbooks at post-secondary level.* Some existing readily available educational resources and learning materials were adopted. Adaptation has been made to cope with specific learning needs. Figure 3 shows as list of English modules for YiJin Programme.
- *Open textbooks at university level.* The existing readily available open e-books were adopted. Depending on the open licenses used, appropriate adaptation has been made, mainly for formatting requirements. Figure 4 shows a list of open textbooks in Arts and Humanities for universities and colleges.

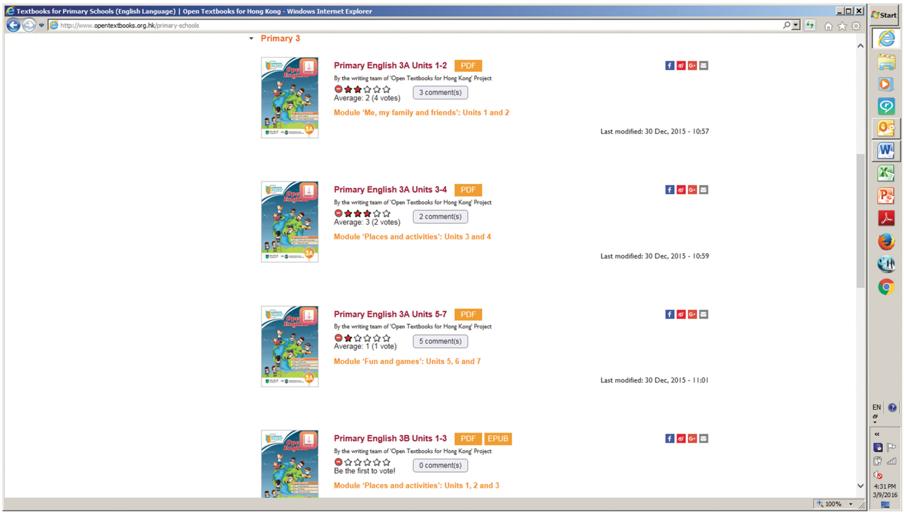

Fig. 2. List of primary 3 English textbooks.

3.4 Quality Assurance Mechanisms

Like other open educational resources, open textbooks are free learning resources available to anyone. Quality assurance mechanisms should be in place to ensure the quality of the open textbooks so as to alleviate the worries and skepticism over the quality of free learning resources. Different quality assurance mechanisms can be adopted, including open and public review, peer professional review, and government or official review.

The following quality assurance mechanisms have been applied.

- For open textbooks at primary and secondary education levels, the prevailing guidelines for school textbooks set out by the government are tightly followed. After going through a serious of rigorous procedures, all these open textbooks are now put under the government's recommended booklist.

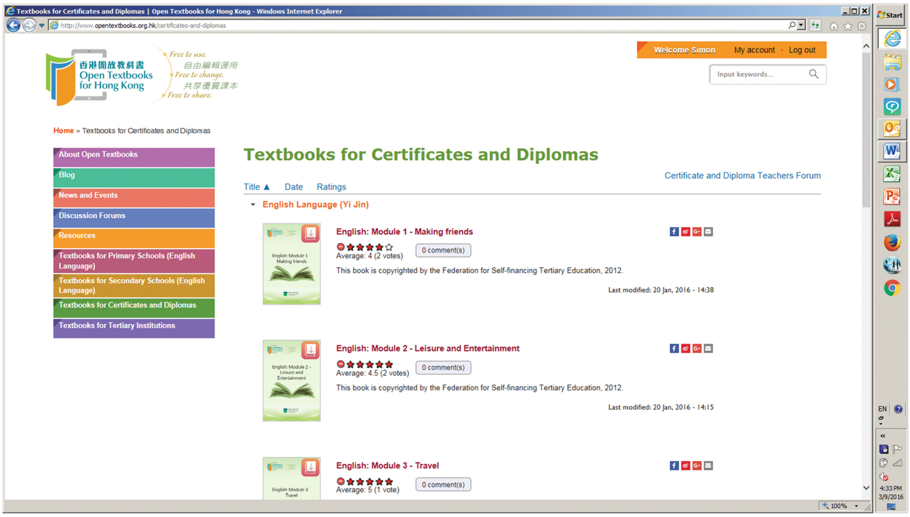

Fig. 3. List of English modules for Yijin programme.

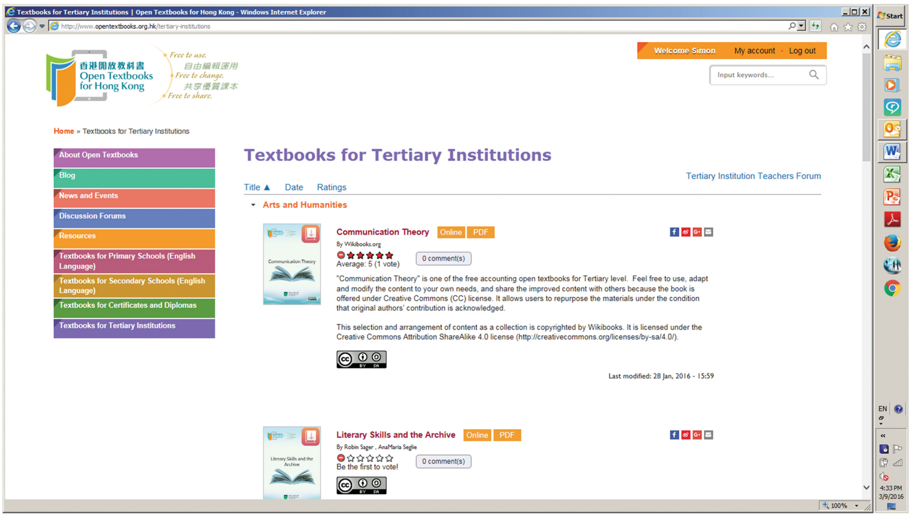

Fig. 4. List of open textbooks in arts and humanities for universities and colleges.

- For open textbooks at post-secondary and university levels, peer professional review must be conducted before release. Reviewers were the peer academic and professional experts in the relevant subjects or fields. By invitation, they did the review in a voluntary basis. In addition, open and public reviews are also allowed. Ratings and comments can be posted for reference.

Besides, a number of systematic studies have been conducted by the Project Team to evaluate the learning effectiveness and learning experience.

3.5 Continuous Capacity Building for Users

As one of the key success factors for the adoption of open textbooks, training should be provided to users, such as the teaching practices with open textbooks [12, 13]. Training should also be provided on the production of open textbooks, such as on authoring digitized materials for textbook contents, and selecting and adapting some legitimate open educational resources. Instructional design and quality assurance for open textbooks should also be covered. Besides, there should be a public platform for users to share experience and exchange ideas.

In the Open Textbook Project for Hong Kong, discussion forums separately for primary school teachers, secondary school teachers, post-secondary teachers and university teachers are established for these peer-groups to exchange ideas and share knowledge and experience, as shown in Fig. 5. Besides, regular seminars, talks and workshops are organized for both the prospective and existing users. These are useful for maintaining a strong user community of open textbooks as well as for building up a culture of using open textbooks in Hong Kong.

Fig. 5. Discussion forums in the open textbooks for Hong Kong.

4 Discussion and Conclusion

Following the rapid development and wide acceptance of open educational resources, open textbooks have evolved as an another source of textbooks for classroom-based teaching and learning. Not only serving the same functions of the traditional printed textbooks, open textbooks also offer many advantages. They are freely available for use and adaptation. Using open licenses, open textbooks can allow users to revise and remix the contents to cater for individual learning needs. These revised and remixed textbooks can be shared for other users. Similar to Wikipedia and Wikibook, open textbooks would be continuously expanded and improved through open sharing. The success of many open textbook systems and platforms in North America has clearly shown this promising outcome.

In Hong Kong, open textbooks are still in the incubation stage. Being one of the initiators of the first official open textbook system in Hong Kong, the author and his team members were lucky to receive generous funding supports in making the open textbooks become a reality in Hong Kong. Taking three years to turn the concepts into actual implementation, valuable experience has been earned. This paper describes this Open Textbooks for Hong Kong project, and shares our development experience from an insider's perspectives. Based on our experience, an open textbook system should have four essential components, namely, an online operating platform, a repository of open textbook contents, quality assurance mechanisms, and the continuous capacity building for users.

Although open textbooks have been adopted in North America for over a decade, open textbooks are very new to the teachers and students in Hong Kong. Being a revolutionary change in practices, the successful adoption of open textbooks has a number of anticipated challenges, such as soliciting the contributors of textbook contents, assuring the quality of textbooks, and establishing a culture of sharing education resources. Continuous public support and user participation are crucial in order to sustain the long-term development of open access textbooks. In any open textbook system, strategic measures should be in place in order to sustain its long-term development.

The following measures can be taken in the steering, governance, community, culture and capacity building, and the on-going development and maintenance of open textbooks. First, public support of open textbooks should be garnered. Second, volunteer groups for open textbook development should be formed. There is much anecdotal evidence showing that volunteerism along can drive a massive project such as Wikipedia and Linux. Third, continuous philanthropic support should be solicited, such as the support from Hong Kong Jockey Club Charities Trust in development the Open Textbooks for Hong Kong. Fourth, quality assurance mechanisms for both the technical platform and the open textbook contents should be enforced. Fifth, from time to time, reviews should be carried out to evaluate the learning outcomes and to seek improvement for enhancing learning effectiveness.

This paper provides a useful reference for practitioners to develop open textbook systems for Hong Kong.

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Assessment and Evaluation

Proposal and Evaluation of an SNS-Based Model for Learning of English as a Foreign Language

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Abstract. In China, the traditional EFL (English as a foreign language) learning model does not meet the need of talent cultivation for lack of an authentic English environment and continuous practice. This study proposed an SNS-based model for EFL learning in a school setting, which embodied the concept of informal learning and community learning. This model was implemented in the course named *College English* throughout one semester, and learning tasks were designed following this model. A survey was conducted to learn about the students' perceptions of SNS-based learning from both online and in-class dimensions. Moreover, the final exam scores of the experimental class were compared with other classes. The results indicated that through this model, students would engage and collaborate a lot in extracurricular learning and inside-class and outside-class dimensions were organically bridged. Although the final scores did not show significant difference, the participants did demonstrate better communicative competence.

Keywords: SNS · EFL · Learning model · Informal learning · Learning community

1 Introduction

English, as a lingua franca of this era, has been taken as a fundamental and compulsory course in the curriculum of China higher education since 1980s. However, English as a Foreign Language (EFL) is not being taught and learnt in a way that produces expected results. The mass-produced students are still "deaf and dumb" even after years of intensive exposure to the target language [1]. One possible reason is that the teachers dominantly take a lecture-based model in which the students are crammed with English and are listening most of the time. This spoon-feeding way greatly dampens students' passion in learning [1]. Another possible reason is that teaching conducted in the classroom are not sufficient for the students to reach an expected level of English, and they invest little time in English after class. Then the question is how extracurricular time could be used ingeniously and strategically to support EFL learning to bridge the inside-class and outside-class dimensions.

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Nowadays, various potentials of Information and Communication Technology (ICT) for language learning have been identified, but to realize and maximize these potentials, engaging students in self-initiated outside-class learning with ICT is essential [2]. In some sense, language is social in nature as it is practically meaningful only when being used for communicative purposes, hence social Network Sites (SNSs) which have great social potentials should be examined closely. However, language teachers are just at the very preliminary stage of utilizing SNSs to implement teaching or to have students practice language skills [3]. SNSs have not been adequately employed in school-based EFL learning in China, and their potentials have not been fully discovered. This paper tries to establish and examine an SNS-based model for school EFL learning which embodies the following goals: (1) SNS-based extracurricular learning poses as an effective part of EFL learning; (2) Inside-class learning and outside-class learning are organically integrated.

2 Theoretical Framework

Although it is not rare for SNSs to be used for language learning, their effects on language learning and the implications for instruction are still unclear [4]. This study tried to investigate into this problem from the perspective of SNSs' role in facilitating informal learning and community learning.

The relationship between inside-class EFL learning and outside-class EFL learning might be represented by that between formal learning and informal learning. Rogers (2004) suggests that formal education alone cannot tackle the challenges of modern society and therefore need to be consolidated by informal practices [5]. The notion of informal learning was first introduced and diffused by Knowles (1950) to account for the power of an informal environment in adult learning situations, emphasizing the flexibility of the learning process and the use of experience [6]. Informal learning can produce a positive return on formal learning by implementing different kinds of strategies and personal goals [7]. Informal learning also helps to broaden the perspective of learning objects and increase learners' engagement [8]. As students progress from low level to high level schools, informal learning gets increasingly important for learning takes place not only in schools but also in the multiple contexts and valued practices of everyday lives, anytime and anywhere [9].

Informal learning also opens up a new space for language learning in that language learning could be regarded as a process of linguistic interactions in informal settings, and language learners can improve their language proficiency by being exposed to authentic language [10]. As for EFL learning in a school setting characterized by formal learning, it is rather difficult to create an immersive environment in which the learners are exposed to English language. In the new age, using SNSs as learning tools could possibly connect informal learning with formal learning as instructors perceived that SNSs-based informal learning could be integrated into formal learning environments to enrich discussions, increase engagement, and broaden connections [11]. In one sense, Internet-based SNSs emerge as an important resource for EFL learners as it makes them constantly informed of a huge amount of "real" examples of language use in contexts [12]. In another sense, EFL skills are likely to be improved through social interaction with other speakers of the language [13] and informal social interaction in EFL learning could enhance language proficiency and confidence [14], in which SNSs are important tools for social interaction.

In a school setting, forming learning communities could be a feasible way to make SNSs-based informal EFL learning effective. A learning community consists of a limited number of people who share common goals and a common culture [15]. Community-based language learning can increase learning interest and encourage active learning, creativity and teamwork [16]. Community learning happens when its members reflect upon their learning and contribute their experiences, observations, and insights to the community [17]. Learning community helps to establish a collaborative learning environment in which a strong sense of belonging and close inter-learner rapport is developed by social interaction and feedback [18]. Class-based EFL learning community is also a typical example of community of practice (COP) for learners have the same interest and goal, and community activities are focused on preset themes. Students are not only to study in class, but also to go deeper into the themes through outside-class activities. Therefore, community learning could not only contribute to the implementation of informal learning, but also bridge it with formal learning.

Based on the theoretical framework, this study proposed an SNS-based EFL learning model and conducted evaluation by implementing it in real teaching practice. The research questions are: (1) Whether the proposed model is effective or not? (2) What could be done to improve its implementation?

3 Proposal of the SNS-Based Model for EFL Learning

3.1 The SNSs Tools to Use

The model was designed upon two social network applications, namely QQ and Wechat, both of which are the products of a noted Chinese company, i.e. Tencent Holdings Limited. Their positions in China are similar to that of Facebook in the world. QQ can be used either on a personal computer (PC) or on a smart mobile phone installed with iOS or Android operating system, while Wechat is usually used on the latter. With QQ, you can: (a) establish a group and further divide its members into several sub-groups; (b) upload files in all formats which can be downloaded by anyone in the group; (c) send files to the others; (d) chat with your group member(s) in a variety of ways, namely text messaging, asynchronous or synchronous voicing and real-time video; (e) make announcements; (f) writing blogs. With Wechat, you can: (a) establish a group; (b) take a picture or short video and post it with a description; (c) forward a posting to a certain group or member; (d) comment on others' postings by writing remarks or simply clicking on "Like"; (e) chat with other members in the same way as QQ, but weaker support for a group chat.

3.2 The SNS-Based Model for EFL Learning

QQ could be better used for organized task-based learning activities as it can be PC-based and emphasizes resource sharing and reflection, while Wechat is better for non-organized learning activities as it emphasizes impromptu production and sharing. Based on this assumption, the model for SNS-based school EFL learning was designed and presented in Figs. 1 and 2.

Figure 1 describes the building of a learning community for a class. The whole class, including the teacher is regarded as a learning community (L-group) and the students are further divided into sub-communities (S-group). S-groups are loosely connected to one another, so inter-group communication is also available. Although the teacher appears in the center of the figure, it does not mean that the model is teacher-centered. The teacher is mainly taken as an organizer and facilitator of learning. The arrows in the figure illustrate that the teacher is connected to each S-group, considering that he/she needs to know what is happening in these groups.

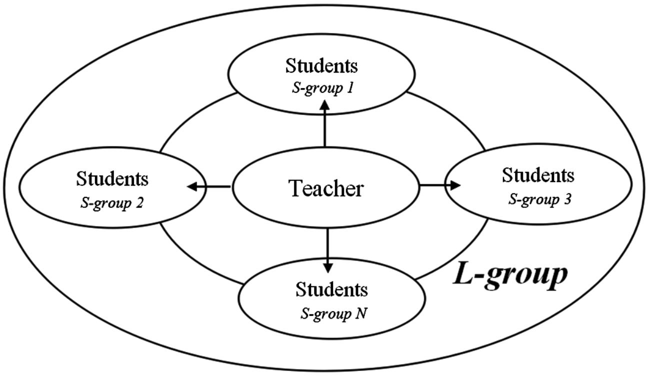

Fig. 1. Architecture of a class-based learning community.

Figure 2 shows how the SNS-based learning process is progressed in a class which is taken as a learning community. In the outside-class dimension, the teacher mainly uses QQ to assign pre-lesson and post-lesson tasks to the students in the L-group with scaffolding materials. Then the students in S-groups deal with the tasks collaboratively mainly via QQ. During the process of doing this job, students may get supports from the teacher and peers mainly by QQ-based communication. Wechat is primarily employed as a tool for both the teacher and students to share in English their personal experiences, good examples of language use, a piece of work produced by themselves, etc. The postings on Wechat will also be commented by peers and the teacher. It is worthwhile to point out that QQ and Wechat overlap regarding their performance in the learning process, e.g. both QQ and Wechat could serve as an online consulting tool. In the inside-class dimension, a larger proportion of time is given to the students to present, discuss, inquire and debate what is related to the task. Teacher's role as a lecturer is reduced. Checking how the students are progressing with the task and commenting on students' performance become important jobs of the teacher in class.

The model presented through the figures embodies the concept of bridging formal learning and informal learning in that what is done in class is closely related to that in extracurricular time. The tasks assigned by the teacher are to be handled during

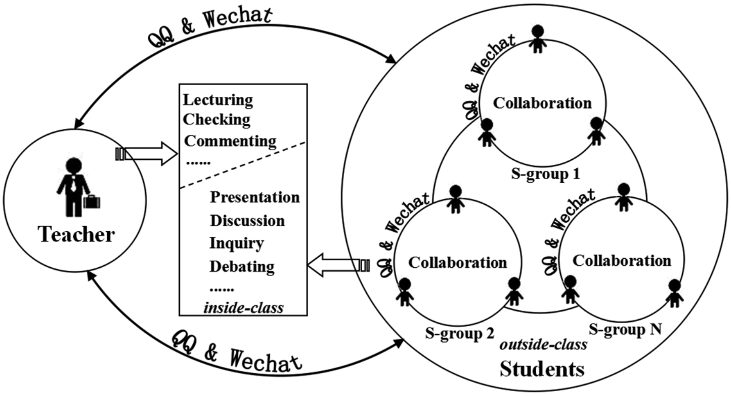

Fig. 2. The SNS-based model for EFL learning.

extracurricular time and presented in class, and students are encouraged to share in English what may not have a close connection to the task. During this process, QQ and Wechat serve as tools for different levels and forms of communication. Learning communities are created on both class and group levels, in which the teacher plays the role as an organizer and facilitator of learning. An atmosphere of collaboration is built when the students work together to deal with the tasks either in the S-groups or in the L-group. Positive stimuli are also produced as the students accomplish the tasks or their postings receive much attention. Moreover, when the students get accustomed to this form of learning, a quasi-authentic and immersive language learning environment is created. Thus the awkward feeling of speaking English outside class, which greatly hinders the improvement of communicative skill, is overcome to some extent.

4 Evaluation of the Model

The model proposed above was implemented at the National University of Defense Technology (NUDT) in the teaching of *College English* (CE), which is a compulsory course for all first year and second year college students of non-English major. This course contains two sub-courses, namely *Reading and Writing* and *Listening and Speaking*, while in this study only *Listening and Speaking* is covered. This course lasts four semesters, but this study was only conducted in the spring semester of 2014. Upon the completion of the course in that semester, a questionnaire was designed to examine the students' perceptions of learning based on this model. Then the data were analyzed in SPSS to find out the indications behind the data. A comparison was also made between the final exam scores of the experimental class with other classes taught in the traditional way.

4.1 Participants

One of the three classes taught by the author was randomly chosen as the participants of the study in the 2014 spring semester. They were 36 freshmen at the age of about 18 who entered NUDT in the 2013 autumn semester, so it was the second semester for them to take the CE course. It is important to know that at NUDT, newly-admitted students are divided into three levels, namely elementary level, intermediate level and advanced level, according to their performance in an English proficiency test. The three classes taught by the author all belonged to the intermediate level. Therefore, it might be assumed that there was no significant difference between them regarding English proficiency. The three classes taught by the author consisted of male students only. The students were put into QQ and Wechat L-groups created by the author at the very beginning of the course. Then according to the model, the students were further divided into groups of five with an exception of six, so there were seven S-groups in total.

4.2 Learning Tasks

The learning tasks were specifically designed for this class in that the traditional way did not entail much use of an SNS. The principles of instructional design lies in four aspects compared with the traditional practice. First, textbooks are not the only source of teaching content. Second, SNS-based learning in extracurricular time is an important approach for knowledge building. Third, classroom is mainly a space for student presentation and discussion with less teacher lecturing. Fourth, the teacher mainly plays the role as an organizer, facilitator and supervisor. The learning tasks are demonstrated in Table 1. The textbook adopted was the *New Standard College English: Listening and Speaking* (Book 3), published by Foreign Language Teaching and Research Press, and in this example unit 4 is chosen whose topic is "Changing Times".

Table 1. A demonstration of the learning tasks.

Tasks	Pre-class tasks	In-class tasks	After-class tasks
Task 1	Individual work: finish the listening exercises autonomously	Teacher-led work: review the listening exercises and explain knowledge points	Group work: revise the report and share it in the QQ group
Task 2	Group work: write a short report on the changing of times with examples	Student-led work: deliver oral reports and discuss upon each report	Individual/group work: further discuss related topics with QQ or Wechat
Task 3	Share in English their personal experiences, good examples of language use, and works produced by themselves (not compulsory). Voice communications are encouraged		

Learning tasks are divided into three parts, namely pre-class tasks, in-class tasks and after-class tasks. Task 1 of pre-class tasks gives the students the autonomy to deal with the learning exercises since different students may vary a lot regarding the repeated times of listening needed for figure out the information. Task 2 of pre-class tasks entails collaborative work among the S-groups to come up with a themed report.

This task mainly entails the use of QQ for communication. Task 1 of in-class tasks is the only part that the teacher will play a major role, which is to compensate the possible defects of autonomous learning. Task 2 of in-class tasks provides a stage for the students to display themselves, discuss upon meaningful issues, and debate upon disparities. Task 1 of after-class tasks makes the students reflect upon their ideas to nurture the ability of critical thinking. Task 2 of after-class tasks promotes the depth of thinking in extracurricular time. Task 3 goes through the whole learning process and is essential in creating a better environment of practicing English. Students are encouraged to post on Wechat what they want to share and have voice communications through QQ or Wechat. The teacher is available throughout the whole process, either face-to-face or online. QQ and Wechat are supposed to play an essential role in doing pre-class tasks and after-class tasks. When students in a particular S-group encounter a problem, they may resort to the teacher or other groups for help through QQ or Wechat.

4.3 Data Collection

Throughout the semester, the experimental class was taught in this pattern. Upon the finishing of the course in that semester, a questionnaire was designed by the author to learn about their opinions of this new learning approach from both online dimension and in-class dimension. The questionnaire contained 12 five-point Likert scale questions, 1 for strongly disagree and 5 for strongly agree. Questions 1–6 were mainly to learn about the students' engagement in online learning with SNSs, while questions 7–12 were mainly to learn about how the online effort would benefit in-class learning and whether the class instruction worked effectively. Altogether, 36 questionnaire sheets were distributed and 36 valid responding sheets were received. Then the data were analyzed in SPSS. Furthermore, the final exam scores of the experimental class were compared with the scores of the other two classes taught by the first author in the traditional way through independent-sample T test.

4.4 Results

Table 2 shows the students' perceptions of SNS-based learning from the online dimension. The mean score of items 1 is well above 4, which indicates that students have adequate technological skills to deal with SNSs. The scores of items 2 and 3 are a bit below 4, which indicates that although collaboration is a distinguished feature of SNS-based learning and most students participate actively, there are some students who may remain reticent. The scores of items 4, 5 and 6 are all above 4.2, which indicates that students are likely to write, speak, read and listen on SNSs, and a virtuous circle will form when students are active in giving comments.

Table 3 shows the students' perceptions of SNS-based learning from the in-class dimension. Item 7 gets a high score, which removes the worry that traditional text-based contents might be neglected within the new model. The score of item 8 reaches 4.67, which indicates that SNSs have bridged inside-class learning with outside-class learning to some extent since what they do outside class will be useful

Table 2. Students' perceptions of SNS-based learning from the online dimension

Item no.	Statement	Mean*	Std. deviation
1	I have no difficulty in using the SNSs	4.61	0.60
2	The collaboration among the group members is strong	3.94	0.71
3	I participate actively in the collaborative work	3.97	0.74
4	I am interested in sharing my English works and personal experience on the SNSs	4.36	0.76
5	I am interested in checking other's English postings on the SNSs	4.22	0.64
6	Positive comments upon my postings will encourage me to produce more postings	4.28	0.66

**The number of students N = 36.*

inside class. Items 9 and 10 get relatively lower scores around 4, which indicates that there are some students who need to be motivated. The score of item 11 is the highest, which indicates that the teacher still plays an important role as the organizer and facilitator of learning. The score of item 12 is also well above 4, which indicates that SNS-based learning will not impose a negative influence upon the efficiency of the class.

Table 3. Students' perceptions of SNS-based learning from the in-class dimension

Item no.	Statement	Mean*	Std. deviation
7	Textbook exercises are appropriately tackled in class	4.44	0.65
8	The class discussion is closely related to what I have prepared outside class	4.67	0.53
9	I participate actively in the class discussion	4.00	0.72
10	I benefit a lot from others' ideas	3.92	0.73
11	The class goes smoothly under the teacher's guidance	4.69	0.47
12	The efficiency of the class is not lowered	4.56	0.69

**The number of students N = 36.*

Table 4 shows the result of the independent-sample T tests. In both cases, the P value is larger than 0.05, which indicates that there is no significant difference between the experimental class and the other two classes regarding final exam scores. The mean score of the experimental class is in the middle. It seems that after implementing the new model for one semester, the participants did not achieve better learning outcomes than other students in other classes. However, it must be pointed out that the final exam was a unified test for the two sub-courses which emphasized reading, listening, writing and translating skills, but not communicative competence which could be a great advantage of SNS-based EFL learning. The traditional learning model is test-oriented while the SNS-based learning model is not. During the study, the

Table 4. Comparison of the final exam scores

Classes	N	Mean	Std. deviation	T-test for equality of means**			
				t	df	Sig. (2-tailed)	Mean difference
Class 1*	36	69.67	5.099	0.087	73	0.281	1.385
Class 2	39	68.28	5.867				
Class 1*	36	69.67	5.099	0.843	74	0.402	−1.233
Class 3	40	70.9	7.323				

* *The experimental class.*
** *Significance level* $\alpha = 0.05$.

participants had many more chances and were more active to communicate both in the written and spoken forms than in the traditional way.

5 Discussions

From the results and analysis, it could be concluded that the SNS-based EFL learning model could bridging inside-class/formal learning and outside-class/informal learning, and creating a quasi-authentic and immersive EFL learning environment. In an ESL (English as a Second Language) setting where the learners are surrounded by English speakers, an environment for learners to be engaged in social interaction outside class is automatically created. However, in an EFL setting, for example in China, this environment is rarely found in the social context, both inside or outside the campus. That is why those who go abroad to English speaking countries will reach a higher English level in a much shorter time than those who have been learning English for years at home. Therefore, the teachers and learners have to work together to create an environment as similar as possible to that in the ESL setting. Online informal learning of English involves a range of comprehension and production activities including social networking with other English learners [19], for which SNSs act as an important medium. The introduction of SNSs into EFL learning brings new perspectives for establishing such an environment. Physical distance and dispersing of learners are no longer major problems. Moreover, SNSs provide a variety of ways of communication which are very helpful for improving the four English skills. However, in order to make the model achieve better learning outcomes, teachers may respect the following considerations.

First, SNS-based learning needs a new pattern of supervision. Compared with traditional CE learning in China for which the classroom is the major place of learning, SNS-based learning attaches great importance to students' extracurricular efforts, hence it is more difficult for the teacher to supervise than in the classroom. Students might be tempted by the attractive links to webpages for entertainment, and thus their attention is distracted to irrelevant things. Also, they will not be reminded by the teacher timely as in the class. Therefore, the teacher must figure out a way to guarantee enough student attention on the learning tasks. Providing enough scaffolding materials might be a possible way because with these materials, students may surf less on the Internet searching for information and thus get less chances of being distracted. Furthermore, effective online supervision should reduce the disadvantage of lacking social cues [20], so the teacher had better frequently present himself/herself in the learning groups via SNSs.

Second, lurking students should be motivated in an appropriate way. There will always be students who would rather remain reticent on SNSs, which may substantially lower their benefits from the learning community. Therefore, certain mechanisms should be worked out to ensure students' engagement in and contribution to the learning community, such as setting a student facilitator in each S-group [21]. Encouraging students to comment on the posted materials by selecting a like/unlike option or attributing a number of stars is a simple way to transform lurking students into participants, reveal their presence, and bring to the fore "the wisdom of the crowd" [22].

Third, individualized instruction should be conducted. SNS-based learning creates an opportunity for individualized instruction by providing data for learning analysis. By analyzing the postings of students, the teacher may identify the lurking students, what are the errors frequently made by particular students and which knowledge point has not been acquired as expected. Obtaining this information, the teacher may impose stimulus on the lurking students, give one-to-one tutoring to a particular student, or further elucidate a knowledge point, all through SNSs. Also, in an SNS setting, the students may feel much freer to contact the teacher for help, which will enable the teacher to learn more about the students and take corresponding measures.

Fourth, SNS-based learning also needs well-made instructional design. SNS-based EFL Learning does not mean that teachers will have an easier job than before, and more efforts might be required from the teacher. Although they lecture much less in class, they will have to prepare a lot apart from the textbook in that the students may present themes and events within a broad scope. Teacher's role as an organizer and facilitator of learning will be strengthened. He/she must set an environment in which students are stimulated to engage more in learning and learning activities are carried out smoothly. Furthermore, teachers must take time to design proper tasks since students learn most effectively by engaging in carefully selected collaborative problem-solving activities under the close supervision [23].

Although SNS-based learning has shown great potential, there are still many difficulties in implementing SNS-based learning on a large scale in the present environment since this form of teaching does not conform to the stereotype recognized by the school authority in China. On the one hand, evaluation of teaching ability still emphasizes some traditional criteria, such as the fluency of the lecture, the legibility of written demonstrations, the degree of teacher's involvement, etc. On the other hand, students' academic achievements are still evaluated mainly by their performance in the final written exams which may neglect some important aspects of progress, such as their progress in critical thinking and communicative competence. Moreover, as for first-year and second-year students, the university restricts the use of computers and mobile phones in case that they might get indulged in playing games. This brings about a conflict between the course requirement and the school regulations. Orchestration could be an opportunity to deal with the relationship between technologies, teachers, students and institutional pressures [24].

6 Conclusion

This study proposed an SNS-based model for EFL learning using QQ and Wechat. Through the model, a learning environment emphasizing collaboration and informal learning was established. In order to examine its effectiveness, this model was implemented in CE upon a class of 36 first-year students at NUDT. The whole class was regarded as a learning community and students were further divided into small groups. A questionnaire survey was made upon the finishing of the course and a comparison was made between the final exam scores of the experimental class and other two classes. Results showed that this model could bridge the inside-class dimension and outside-class dimension and students' engagement was improved. However, for better learning outcomes, teachers will have to take more considerations, such as supervision, motivation, individualized instruction and instructional design. For a large-scale implementation of the model, there is still a long way to go.

Limitations of this study lies in the following aspects. First, the efficacy of the teaching model is mainly examined by the students' perception, but not their real progress with English. Second, students' engagements in SNS-based learning were not measured by a statistical analysis of the factors like their postings, responses and the number of online communications. Moreover, differences between groups were not observed, which might be important for finding a favorable model of group collaboration.

Future studies could focus on the deeper and micro things, such as content analyses of the students' postings and comparative studies between S-groups of different performance. Thus to learn more about the learning process and the factors affecting learning outcomes and make better learning strategies.

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A Study on Non-english Majors' Cognitive Adaptation and Learning Performance in Flipped Classroom

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Abstract. This paper, using a mixed method, designed the college English Flipped Classroom from the perspective of curriculum, and examined the students' cognitive adaptation, engagement and application skills. It was found that the students differed in cognitive adaption (students good at listening and speaking performed better), and their listening and speaking were improved. Moreover, speaking significantly correlated with in-class interaction and group collaboration. Finally, it was suggested that based on the level of speaking and listening, stratified teaching could be carried out to provide pre-class, in-class and post-class facilitation respectively.

Keywords: Flipped classroom · Cognitive adaptation · Learning engagement · English application

1 Introduction

1.1 Background

With the acceleration of Globalization, English application (including communication, writing, cross-cultural communication and professional English) is increasingly important for people's work and life. Chinese Education Ministry promulgated "The Instructional Guideline for College English curriculum (Trial)" [1] and set up the goal for college English teaching: to cultivate students' comprehensive application, especially in listening and speaking. However, a widespread problem with Chinese students is their incompetence in speaking and communication [2]. On the one hand, this is related to students' learning habits and psychology. On the other hand, it is influenced by teaching methods [1]. How can students' speaking and communicative skills be improved? A reform on college English teaching with Flipped Classroom is emerging. The concept of Flipped Classroom comes from western countries. Will Chinese college students used to traditional teaching adapt to it? This paper will try to explore the problem.

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1.2 Flipped Classroom

Flipped Classroom or "Inverted Classroom", refers to the readjustment of in-class and outside class time, and transfers the learning decisions from the teacher to the students. In this mode of teaching, students are able to concentrate more on project-based learning to handle the real life challenges and problems, so as to gain a deeper understanding [3]. Flipped Classroom is completely different from traditional teaching in terms of teaching methods, relationship among teacher and students, learning activities and evaluation. Students are expected to learn materials by themselves before the class, to discuss and exchange ideas of problem solving in class, and to synthesize knowledge or finish group task after class. In theory, students should have more opportunities for communication and group cooperation to enhance the students' English application and cultural understanding.

1.3 Student Adaptation

Student adaptation refers to students' endeavor with which they develop their knowledge and skills to adapt to a specific learning situation [4]. Feng and Li [5] defined student adaptation is that the students adjust their psychological and behavioral status to meet the requirement of learning situations and complete the learning tasks, making balance between environment and their inner situation. Learning adaptability involves two dimensions: cognitive and non-cognitive. Cognitive aspects include adaptation to learning method, learning environment, content, relationship among teacher and students, and assessment. Cognitive adaptation in Flipped Classroom can be optimized through specific intervention strategies. Non-cognitive aspects, including motivation, self-efficacy, persistence, personality and emotional factors, play the role of strengthening and supporting cognitive adaptation [6]. In this paper, we will mainly focus on cognitive adaptation.

1.4 Learning Engagement and English Application

Learning engagement is not only expected results, but also the factor influencing learning. It could be explained in two levels, at the individual level, learning engagement is the student's internal tendency to develop skills and characteristics so that he or she could gain the meaning from the world and reach the learning goals [7, 8]. Helping students to build up confidence and be familiar with learning materials might be helpful to learning engagement at individual level [8]. At the social level, learning engagement lies in the social features developed from the relationship between teachers and students [9], focusing on improving the social conditions for learning involvement. Therefore, attractive activities or situations, social interaction and tolerance for dissent can enhance social-level learning engagement [10]. The English application mainly refers to the ability of the college students using English as a tool, carrying out daily and general business communication [1]. In particular, it includes listening, speaking, reading and writing, cross cultural communication and professional English.

1.5 Research on College English Flipped Classroom

The study on college English Flipped Classroom mainly focus on two aspects: one is on teaching approaches. Researchers described the application and advantages of college English Flipped Classrooms [11–13], such as various pre-class support, and in-class activities including role play, games, and debates. The other is on adaptation. For instance, Bi [12] reflected on whether Flipped Classrooms were needed considering the status quo in China, and pointed out that Flipped Classrooms should be adjusted in accordance with the teaching conditions and students' adaptation in different universities. Wang [6] stated that the traditional teaching modes are deeply rooted in China and therefore not adapted in Chinese classrooms, for which teachers should have more access to the training of information technology and they should be encouraged to carry out reforms. Zhao and Xu [6] analyzed the possible difficulties and causes in adapting the curriculum, learning environment, the inversion of the roles of students and teachers, and the evaluation system, and provided solutions accordingly. What is in common for these studies is that they all focus on empirical thinking and lack empirical data and analysis. As a result, the solutions provided are too general and need in-depth elaboration in practice. This study conducted an in-depth study after one semester's implementation of Flipped Classroom for non-English majors, exploring the students' adaptation and their English performance of engagement and application based on qualitative and quantitative data so as to give more specific suggestions for Flipped Classroom in Chinese college English reform.

2 The Design of the Study

2.1 Research Questions

A Flipped Classroom changes the traditional classroom structure. It encourages students to conduct self-learning before and after classes, discuss and communicate in classes, and highlights students' communication. Are traditionally-bred students adapted to the changes in cognition? This study addresses the following issues: firstly, how were students adapted to Flipped Classrooms cognitively? Secondly, how did students perform in Flipped Classroom? Thirdly, what are possible ways to improve students' adaptation?

2.2 Study Subjects

The subjects of this study are 150 freshmen from Inner Mongolia University of Science & Technology (from different majors, including Mechanical Engineering, Electric Engineering, etc.), all of whom were selected according to their English scores in the Entrance Exam. The sample number is 150, and 128 were collected. Among the subjects, 91 students were male and 37 female, with the average age of 18.6.

2.3 Methodology

Qualitative and quantitative methods were used in this study. Students' adaptive behaviors were examined by interview with students covering three dimensions: pre-class self-learning, in-class communication, and after-class projects. In addition, open-end questions aimed to tackle students' adaptation and possible suggestions were given to students: "Are you satisfied with the teaching reform? What difficulties do you have? What suggestions do you have to improve your Flipped Classroom?" students' engagements were from the Likert scale of student learning engagement with "no, a little, often, very often" as four choices scoring 1–4 respectively. This scale includes group work, pre-class reading, in-class learning, interaction with the teacher and after-class exploration, modified from Student Learning Engagement from London Education Institute according to the specific need in Flipped Classroom, which is of good reliability and validity and hence widely used. Students' English application was evaluated through eight homework covering reading, writing, listening, communication and professional English with the criteria of expression and content.

2.4 Process

Three domains were designed: objectives, content, Flipped Classroom activities and evaluation method, as shown in Table 1:

Table 1. The design of college English Flipped Classroom

Objectives	Content design	Flipped classroom	Evaluation
Basic language skills including listening, speaking, reading, and writing	Campus life: comparing the different between high school and college, and making plans	Pre-class activity: reading and listening about campus life; orientation tour; in-class activity: communication in English; after-class activity: making an audio clip with a partner	Evaluation on language proficiency (English songs, pronunciation)
Basic language skills including listening, speaking, reading, and writing	Environment: orientation tour, studying issues on environmental pollution and protection, and making crossword puzzles	Pre-class activity: research on environment-related issues; in-class activity: communication in English; after-class activity: shooting a video clip of the orientation tour on campus	Communicating in English Writing

(*Continued*)

Table 1. (*Continued*)

Objectives	Content design	Flipped classroom	Evaluation
Cross-cultural communication	Entertainment: making Thanksgiving posters and conducting an open house activity	Pre-class activity: research on Thanksgiving; in-class activity: open house; after-class activity: writing	Communicating in English, multi-media facilitation, cross-cultural communication
Professional English Application	Technology: conducting a simulated interview; introducing their majors and the prospects	Pre-class activity: research on their respective majors: what it is about, its basic principles and prospects; in-class activity: communication in English; after-class activity: write a report	Communicative skills: speaking and writing

Based on the curriculum, the design covers four domains: Firstly, the objective domain: promoting students' English application ability in accordance with the teaching objectives, including listening, speaking, reading, writing, cross-cultural communication, and the application of English for professional purposes. Secondly, the content domain: applying the above skills in four modules, namely, "campus life", "environment", "entertainment", and "technology". Thirdly, Flipped Classroom: students study digital materials in virtual learning spaces and finish the pre-class assignments, including movies, video clips, audio clips, and documents, communicate and evaluate each other's work in class, and polish their assignments in both virtual and physical spaces (such as the campus, market, and community) after class. Since the learning situations and materials come mostly from students' living environment, Flipped Classroom provides a project-based learning environment which relies heavily on both self-learning and team work and offers abundant opportunities for the application of English skills. Fourthly, the evaluation of English learning: the evaluation focuses on the learning process, which covers the language skills in students' reports, their vocabulary, content, audio and video clips made by them, the innovation of their role plays, their ability to conduct cross-cultural communication, and their capability in introducing their majors in English.

After designing of Flipped Classroom, the participant teacher implemented it for 13 weeks, with 4 h each week. In the end, an engagement scale questionnaire was distributed to students, and evaluation was conducted on students' assignments at the end of the semester.

2.5 Data Analysis

SPSS Window19.0 was used in analyzing the reliability and validity of the learning engagement scale. After exploratory factor analysis, general descriptive was conducted, followed by mean difference and variance analysis. The correlation analysis between cognitive adaptation and students' application abilities was performed. For the qualitative data, content analysis was done, following the process of encoding, login, keyword extraction, and theory induction.

3 Study Results

The English cognitive adaptation, learning engagement and application of the students are discussed and possible suggestions will be proposed accordingly.

3.1 The Cognitive Adaptation of the Students

3.1.1 Students' Adaptation to the Learning Method

Students gradually adapted to the learning method of the Flipped Classroom before, during, and after classes. 71 % of the students said the Flipped Classroom was challenging to them, 26 % indifferent, and it was not a challenge at all for 3 % of the students. Compared with traditional English classrooms, students should have better self-control, for which many students were uneasy at the beginning. For example, students need to take the initiative and spend more time on self-learning and pre-reading, which was quite challenging for them. "You cannot finish the pre-class assignments if you don't have enough self-control." During class periods, students need to conduct a lot more communication both inside and outside their groups. 84 % of the students had more opportunity to communicate in English. However, their spoken English and listening ability have become the main factor for their adaptation. For students with adequate spoken English ability, "in the past all we had to do was to sit and listen, not we are talking! We feel both pressured and exciting!" "The atmosphere in the classroom is relaxing and interesting. We are willing to speak." However, for students with limited spoken English ability, they said "we were afraid to speak and couldn't speak well, so we just gave up." After class, students need to explore further based on the class discussions. "In the past, we were pushed by teachers, but now we were pushed by our tasks. We need to do a lot of research before and after class." "For the Thanksgiving project, we discussed a lot during the class periods, and we came across a lot of problems. Then we researched about the different Thanksgiving customs after class." In general, students were more aware of the necessity of self-learning. "It occurred to me that we need to rely on ourselves in college."

According to students, in-class and outside class learning are reciprocal and mutually interactive. They need to do self-learning before class, discuss and find questions during the class, and explore further after class. "During the class time, you can apply what you have learned before class. And after class, you will be reminded of what you have learned during the class. It's a circle and a two-way interaction."

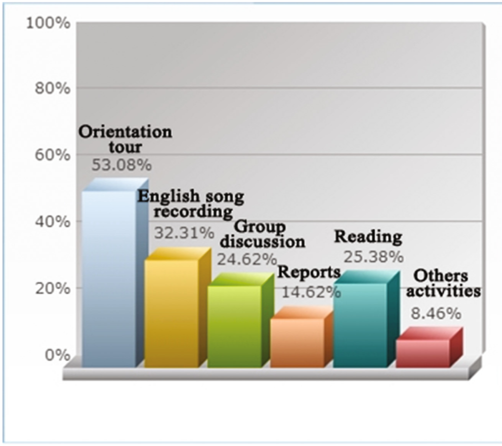

Fig. 1. Students' favorite activities

3.1.2 Students' Adaptation to the Learning Environment

The learning environment of the Flipped Classroom was also different from the traditional one. Pre-class and after-class activities mostly took place in virtual or real environment, among which reading or research was done before class, and discussions were conducted in the classroom. As shown in Table 1, the most popular activity was the orientation tour, followed by English song recording, reading, group discussion, reports, and others activities. Therefore, real environment is most popular with students. In these environments, students learn through finishing their tasks and cooperating with other group members. The most unpopular environment is in-class communication and outside class reading.

3.1.3 Students' Adaptation to the Learning Materials

Students showed great interest in their learning materials, which were not from traditional textbooks. Four modules closely related to their lives were arranged, namely, "campus life", "environment", "entertainment", and "technology". Despite the fact that the amount of work was significantly more than they used to have in high school, the learning materials were closely related to their tasks and class discussions. "We don't need to learn by rote. On the contrary, we can follow our interest." Therefore, they liked this flexible arrangement. However, 40 % of the students showed concern that they encountered some difficulties in reading, in-class interaction, and homework projects due to limited speaking and listening skills and small vocabulary. "In class, I can't express myself freely, so I got detached and began to play with my cell phone." (Some students said).

Some students worried about the upcoming CET4 and CET6 tests: "can we handle the test without a textbook?" "Can we scrape through the exam without a systematic study of vocabulary and grammar?" Nevertheless, some other students were not worried: "vocabulary and grammar are already integrated in Flipped Classroom. It is fairly easy to pass an exam once our comprehensive English proficiency is boosted and we have a better sense of the language."

3.1.4 Students' Adaptation to the Changed Roles of Teachers and Students

In a Flipped Classroom, the teacher is the guide and facilitator. There is more communication between students and among groups, and more competition as well. As to teacher-student relationship, most students think it is more harmonious: "our teacher does not put on a poker face and give us lectures. Instead we interact more." As to cooperation and competition among students, most students like the in-group cooperation. Some groups voted to make a decision, and some groups encouraged every group member to speak their minds and made the final decision by pooling the best ideas. As to the motivation of the group members, some groups think that inter-group competition is an important factor. Although group work was good for the groups' achievement, some students just took the ride.

3.1.5 Students' Adaptation to the Changed Evaluation Method

A comprehensive evaluation system is introduced in this Flipped Classroom with an emphasis to the process in order to enable full participation of the students in all the assignments. Therefore, there was no final exam. To be more specific, the final score consists of 10 separate parts, consisting 8 assignments plus evaluations made by group members and the teacher. According to students, the evaluation method is such a novelty that it was the first time they realized good team work could play a positive role in their final score. Besides, an evaluation system which emphasizes comprehensive application ability is fairer to the students. Still some students showed concern that this evaluation system was quite different from the criteria of CET 4 and CET 6, therefore they were worried that they "might be wasting time on something not targeted for CET 4 and CET 6".

The above is an analysis of the adaptation of students from the cognitive aspect. In general, students were adapted to the learning method, learning environment, curriculum, teacher-students relationship, and the evaluation system. The biggest obstacle encountered by students was inadequate self-learning, speaking, and listening ability, which in turn affected their adaptation. Besides, their group collaboration ability should be enhanced. Nevertheless, 98 % of the students would still prefer to choose Flipped Classroom rather than traditional teaching method. The reasons are: students are willing to take the challenge, since they improved significantly in this classroom, especially in speaking and communicating, and self-learning ability as well. 5 % of the students mentioned that they were able to focus on improving their English due to this non-traditional teaching method. "I was very proud to be here and be a member of this class. Life is full of challenges, so I'm willing to take it. I believe that I will excel with my teacher's guidance and my classmates' help. I will learn practical stuff here, not only rote memory." (One student said) Only students with very limited speaking and listening ability could barely adapt to the Flipped Classroom.

3.2 Students' English Learning Engagement and Their Application Ability

First, exploratory factor analysis was carried out for learning engagement scale, with varimax rotation, and 32 items were reduced into for five factors: reading before class,

class group work, teacher interaction, classroom discussion and supplementary learning after class. The total Alpha Cronbach's system of the students' learning engagement scale is 0.975, and the reliability coefficient of each dimension is between 0.6–0.85. The mean of English learning engagement (see Fig. 1) is between 2.21 and 2.9, among which the group work is the highest (M = 2.88, SD = 0.56). For students' English application ability, the highest is the dialogue (M = 7.58, SD = 0.8), and other English proficiency scores between 7–7.58 (each standard is divided into 10 points).

Independent sample t test was conducted in accordance with the sexes. It was found that girls took more initiative in group work ($T = 1.935$, $P < 0.05$), and boys more enthusiastic in interaction with teachers ($T = 2.237$, $P < 0.05$), indicating that girls were more willing to communicate and participate in group work and boys more inclined to interact with teachers.

Based on the correlation analysis (Table 3) on students' learning engagement and English application ability before, during, and after classes, their listening and pronunciation ability cross-related to their cognitive engagement and interaction with teachers in class, with correlation coefficients 0.242 and 0.138 ($P < 0.05$) respectively. Students' scores in dialogues were positively related to their engagement in team work, and the correlation coefficient was 0.227 ($p < 0.05$). Learning engagement in other aspects showed no correlation to their application ability (Table 2).

Table 2. Descriptive statistics of students' English learning engagement and their application ability

	Score	N	Mean value	Standard deviation
Students' English application ability	Total	128	74.6930	5.66469
	Communication		7.5879	.80039
	Professional English		7.5797	1.14853
	Writing		7.4754	1.17049
	Listening		7.1738	.91497
	Reading		7.0750	1.43790
Students' English learning engagement	Group work	130	2.8828	.56341
	Pre-class reading		2.7498	.66688
	In-class cognitive engagement		2.5188	.53270
	Interaction with the teacher		2.2877	.69728
	After-class exploration		2.2009	.63611

Table 3. The correlation of students' learning engagement with English application ability

	In-class learning	Team work	Interaction with teachers
Listening and pronunciation	0.242*		0.138*
Dialogues		0.227*	

Notes: * means $P < .05$, ** means $P < .001$

The above analysis indicates that students' learning engagement in class is positively correlated to their ability. In other words, in-group discussion, group reports and interaction with teachers in a Flipped Classroom play a positive role in the improvement of students' spoken English.

3.3 Suggestions

Students have put forward some suggestions for the teaching method, teaching support, and test-taking support.

3.3.1 Teaching Approaches: Creating More Opportunities to Communicate

As mentioned before, limited speaking and listening ability is the weakness for non-English majors. In the interview, most of them hoped that teachers could provide more opportunities for them to communicate, for instance, games, debates, and other interesting activities, to lighten the atmosphere in class and encourage students to communicate in English. Apart from that, some students complained that the classes progressed slowly: "only one task for two class periods is too easy". It is suggested to increase the abundance of the learning materials, provide various incentives, and fasten the pace of the classes to ensure full participation of students. Besides, students hoped that they could have more outdoor activities, such as open house and field trips to use English in real situations instead of the classroom only.

3.3.2 Stratified Teaching: Providing Correspondent Facilitation for Students of Different Levels

Students of different levels of spoken English varied in their adaptation in the Flipped Classroom. Therefore, students with similar levels could be put into the same group and differentiated facilitation could be provided to them accordingly. For students with limited speaking and listening ability, discussion scaffoldings including dialogue or discussion models, vocabulary cues, videos can be provided for them during class, in addition to more materials before class, which may help the silent students to be more engaged in class.

3.3.3 Taking CET 4/6 into Account

With an evaluation system emphasizing on the process, students did not have to take a final exam. "The teacher has suggested us to listen to English news programs like VOA Special English, which will help us in passing CET 4", said some students. However, they were worried about the upcoming CET 4/6, since training for the test was not included in the curriculum. Nevertheless, exceptionally advanced students were confident that their comprehensive English level was upgraded thanks to the study of this semester and it would not be a difficulty for them to pass CET 4 as long as they were committed to studying English.

4 Conclusion and Discussion

This paper, using mixed methods, designed the college English Flipped Classroom and acquired the knowledge of the cognitive adaptation, learning engagement and application ability of non-English majors. Compared with previous studies, it was not limited in only teaching methods, but re-designed college English curriculum with a comprehensive considerations to its objectives, content, implementation, and evaluation. In terms of research methodology, it adopted qualitative and quantitative methods instead of empirical thinking, as is commonly found in previous studies. The conclusions are as follows:

Firstly, a Flipped Classroom is not a cure for all non-English majors. The overall engagement score is not high (between 2 and 3). Their speaking and listening ability plays a decisive role in their in-class engagement and communication. According to the theories of situated learning, it is a crucial process for students to gradually become a core member. However, this study shows that some students with limited speaking and listening ability were gradually detached from the other participants. Only very few students could become core members. According to Mills, Herron, and Cole [14], customized guidance by the teacher may boost students' learning engagement. Only with differentiated support to weak students, can they be more engaged in class discussion. This needs to be further explored.

Secondly, the speaking ability of students is positively correlated to class interaction and group work. As the study indicates, teacher-students interaction and group work in a Flipped Classroom may play a positive role in improving students' spoken English.

Thirdly, how can we make an objective evaluation of the learning results in a Flipped Classroom? The evaluation system used in this study mainly addresses the assignments and scoring made by group members and teachers, in accordance with language and content. Can such an evaluation system accurately reflect students' application ability showcased in different times and spaces? Further discussions may be needed.

Fourthly, compared with traditional classroom, Flipped Classroom offers much more opportunities for students to conduct self-learning, team work, and spoken English practices. However, some students may question the "validity" of such a Flipped Classroom since they are used to traditional test-oriented learning. How to maintain a balance between the teaching reform and the pressure faced by students is an impending issue.

In summary, students' cognitive adaptation has been increasing in the Flipped Classroom. Most students are willing to continue to learn in Flipped Classroom, since they have more opportunities to conduct self-learning, group work and spoken English practices. However, not all students adapted well cognitively. Students with limited speaking and listening ability could not get enough chances to participate in the Flipped Classroom, for which stratified teaching may be considered and differentiated facilitation may be provided for students of varied levels, such as supporting materials and self-evaluation feedbacks before class, differentiate discussion scaffolding during the class, and various incentives after class.

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Connected Classroom Climate in Hybrid Classroom: Model and Comparison

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Abstract. This study defines the hybrid classroom, provides a best-practice model for the implementation, and explores the effectiveness of connected classroom climate in respect to students' perception based on the Connected Classroom Climate Inventory. Based on the findings of this study, the authors conclude that the connected classroom climate in the hybrid classrooms can be equal to, or greater than, the traditional face-to-face classrooms.

Keywords: Student perception · Connected classroom climate · STEP · Hybrid classroom · Google classroom

1 Introduction

Amborse *et al.* [1] defined classroom climate as the intellectual, social, emotional, and physical environments in which our students learn. Accordingly climate is determined by a variety of interacting factors that include faculty-to-student interaction, instructional tone, stereotyping or tokenism, course demographics, student-to-student interaction, and the range of perspectives represented in the course content and materials [1].

The topic of classroom climate has become a focus of attention due to its significance in affecting student learning. Relevant research has covered various aspects of the topic, including: instructor-student interactions, classroom activities, types of classroom climate, and classroom climate measurement [2–6].

Among the various types of classroom climate, connected classroom climate is defined as student-to-student perceptions of a supportive and cooperative communication environment in the classroom [7]. Students' perceptions of connectedness of classroom climate has been linked with retention and academic success [7]. However, as Dwyer *et al.* [7] concluded that research focus has been emphasized toward on teacher-to-student interactions in the college classroom, while very little exploration has focused on student-to-student behaviors influencing students' perception of a connected classroom climate.

Understanding and developing a connected classroom climate may become increasingly challenging in the digital age. Technology has profoundly influenced

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teaching and learning [8–10]. Hybrid courses, which are also referred to as web-enhanced, blended, or mixed mode learning, combine instructional elements of traditional face-to-face and online course formats [11]. Specifically focused within higher education, accessibility and changing student demographics have increased the attractiveness and reliance on hybrid course delivery [12]. Furthermore, as universities seek to reach more diverse student populations while managing modern budgetary restraints, it is likely that hybrid-style delivery will continue to grow [13].

Prior research has explored the effectiveness of hybrid learning, as well as, the advantages and disadvantages. However, very little research has focused on connected classroom climate. One reason for limited investigation may include the lack of a definition for classroom in hybrid learning contexts. While, other reasons may include the unclear or immature status of hybrid classroom models. Therefore, this study focused on:

- clarifying the definition of 'classroom' in hybrid contexts;
- providing a successfully tested hybrid classroom model;
- evaluating the effectiveness of a hybrid classroom climate; and
- contrasting the connected classroom climates of traditional and hybrid models.

2 Relevant Literature and Study Framework

2.1 Defining a Hybrid Classroom

The traditional face-to-face classroom provides a space where learning can take place uninterrupted by outside distractions [14]. In comparison, a hybrid classroom is a combination of virtual space and traditional classroom models. Through this approach, students communicate with the instructor and their peers in both real-world and virtual classroom spaces.

This study is based on the definition hereby stated. The traditional classrooms provided foundations for new concepts allowed time for sharing of individual/group-based learning experience. The virtual classrooms utilized Google Classroom to develop individual/group-based projects, host communication, maintain schedules, and submit/receive assignments.

2.2 Defining a Google Classrooms

Google Classroom (see Fig. 1) is a free web-based platform that integrates users' Google Apps for Education account within other cloud-based Google Apps services (e-mail, documents, presentations, sites, drawing, calendars, etc.). This platform of services is secured behind a single user login to simplify usability and provides a minimal design for improving communication and content distribution/collection. Teachers can quickly analyze student progress, provide real-time feedback, and host necessary communication [15].

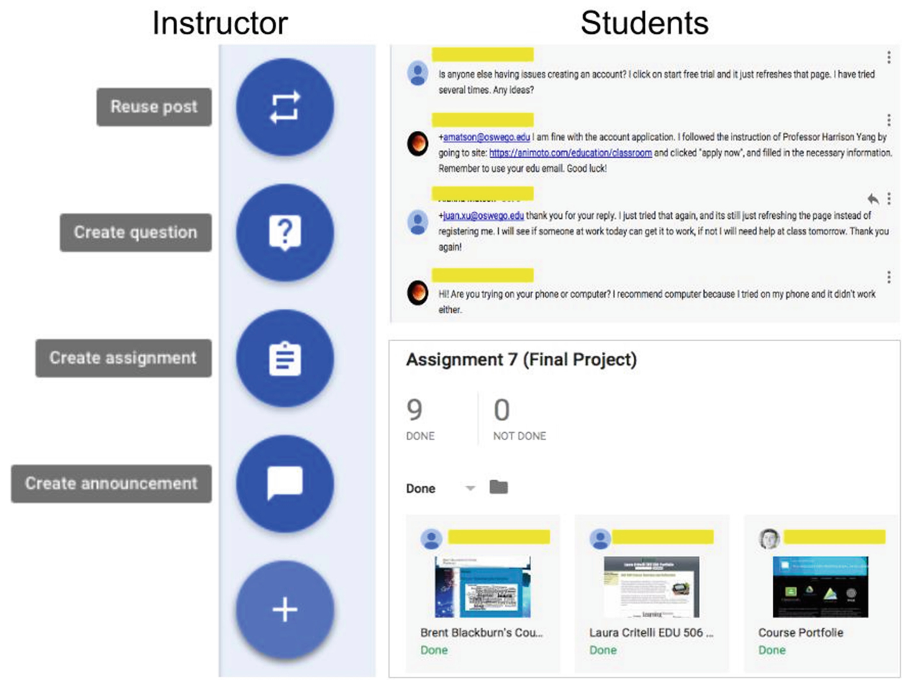

Fig. 1. The virtual Google Classroom

2.3 Defining the STEP Model for Hybrid Courses

In order to cultivate a positively connected classroom climate, the authors of this study aligne study framework with the STEP model, which was developed from our previous research and is a set of strategies for promoting active learning communities and enhancing social presence in online and blended learning environments [16–19]. The STEP model emerged as a result of using a systematic approach to break isolation between instructors-to-students, students-to-students, and students-to-environment. In hybrid courses, the STEP model was used to integrate traditional face-to-face learning with the online virtual learning environment to enhance students' learning experience.

The STEP model consisted of four interrelated components [16, 19]:

- *scaffolding* before starting new learning topics;
- *transaction* during the learning process;
- *evaluation* during and after each learning topics; and
- *presentation* of outcomes.

As show in Fig. 2, the locations of STEP components were split between the two classroom environments. *Scaffolding* was primarily conducted face-to-face, *transaction* was primarily conducted in the Google Classroom, and *evaluation* and *presentation* were carried out both in the physical and virtual classrooms. This approach highly reflected the blended nature of a hybrid classroom, and enhanced the connectedness of the classroom climate.

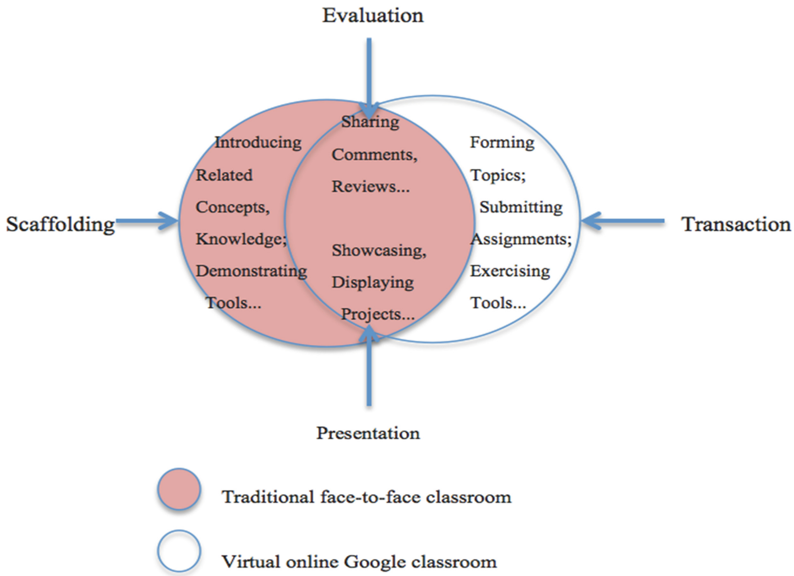

Fig. 2. Hybrid classroom STEP model

Scaffolding is the idea of gradually easing students into what are likely to be challenging tasks through creating a supportive structure to guide their work [20]. In hybrid courses, scaffolding was mostly the instructor's responsibility. Through the process of instruction, demonstration, and discussion, ideas were extended into real world situations, and projects were outlined for a hands-on approach.

Transaction in hybrid courses primarily takes place in the virtual classroom, and was primarily the responsibility of students. Transaction includes forming topics and ideas, going through the learning materials and resources, exercising tools, completing and submitting assignments, etc. To keep students actively participating in learning activities, online discussion was encouraged. The instructor's transactional role was collaborative. Online office hours were set to allow direct communication, although the goal was to provide prompt responses throughout the whole experience. When common questions/concerns appeared, the instructor utilized open communication by interacted posting information on a digital bulletin board in the virtual classroom for all to see.

Evaluation of students' performance was periodic to redirect inactive students and reinforce active students along their journey of mastering course content [21]. The hybrid classroom evaluation was done both face-to-face (summative assessment) and online (formative assessment). Beyond instructor evaluations, peer evaluations were utilized to foster a positive classroom climate and encourage constructive interaction.

*Presentation*s provided a vehicle for both active and reflective learning in the face-to-face portion of the hybrid course structure. Opportunities for students to present their ideas, methods, and products were abundant throughout and designed to lead into reflective discussions which promoted collaborative learning. Along with face-to-face presentations, digital copies of presentations were made available in the online classroom to provide an archived resource for the enrolled students.

3 Research Objectives and Method

3.1 Research Objectives

The research objectives of this study were to (1) explore the connected classroom climate of hybrid classrooms, and (2) compare the connected classroom climate of hybrid and traditional face-to-face classrooms.

3.2 Participants and Courses

The participants of this study were enrollees from two graduate courses offered at a 4-year comprehensive university in the upstate region of New York, USA. One course was entitled *Portfolio/Synthesis Seminar* and the other *Computer Applications and Resources in Teaching*. Participants were selected by way of convenience sampling, as one of the researchers was the instructor of both courses. Most participants in these courses were part-time in-service teachers located in the same geographical area, who pursued graduate studies in content specializations of literacy, biology, chemistry, mathematics, social studies, and technology.

The *Portfolio/Synthesis Seminar* introduced issues relating to professional development, especially focusing on professional portfolio development and other activities that further support and contribute to the educational field. The *Computer Applications and Resources in Teaching* focused on the integration of computers into teaching and learning. Instructional tools and techniques were introduced and effective technological communication is practiced.

Both courses were evaluated at similar levels of difficulty, managed with the same approaches, utilized the same virtual classroom technologies, and offered as hybrid courses.

3.3 Data Collection and Instrumentation

To obtain specific information and assess the effectiveness of the hybrid classroom model on the sense of connected classroom climate, one section of *Portfolio/Synthesis Seminar* (n = 13) and one section of *Computer Applications and Resources in Teaching* (n = 9) were selected for this study. All 22 students received Connected Classroom Climate Inventory (CCCI) survey [7] at the beginning and the end of the semester. The beginning pre-semester survey (pre-test) is to examine their perception of connected classroom climate in traditional classroom, while the ending post-semester survey (post-test) is to examine their perception of connected classroom climate in a hybrid classroom. All students completed the survey and 20 responses (91 %) were valid. Additionally, students' self-flection reports and online communications were qualitatively examined.

The CCCI, which was developed to measure student-to-student perceptions of the classroom climate, included 18 items [7]. Directions instructed participants to respond on a 5-point scale the extent to which they agree or disagree with each statement (1 = Strongly Disagree to 5 = Strongly Agree). Minor adjustments were made to the

CCCI for purposes of this study. For example, the statement, "Based upon my experience in the face-to-face classroom…" was added at the beginning of all items on the pre-test, and the statement, "Based upon my experience in the hybrid classroom…" was added at the beginning of all items on the post-test.

4 Results and Discussion

Pre-test and post-test data were collected respectively, and then analyzed for comparison. As indicated in Table 1, the connected climate of both traditional and hybrid classrooms were perceived as good by the student respondents. Survey items from the

Table 1. Students' perception of connected classroom climates in CCCI survey

Connected classroom climate	Face-to-face		Hybrid		*t*
	M	*SD*	*M*	*SD*	
1. I feel a sense of security in my class	4.45	0.69	4.57	0.60	0.59
2. I have common ground with my classmates	4.10	0.72	4.24	0.77	0.59
3. I feel strong bond with my classmates	3.65	0.99	3.48	0.81	0.59
4. The students in my class share stories and experiences with one another	4.25	0.72	4.00	0.84	1.01
5. The students in my class are friendly with one another	4.25	0.64	4.71	0.46	2.61*
6. The students in my class respect one another	4.20	0.77	4.52	0.60	1.47
7. I fell included in the class discussion in my class	4.30	0.86	4.48	0.68	0.73
8. The students in my class are courteous with one another	4.35	0.67	4.62	0.50	1.44
9. The students in my class praise one another	3.60	0.94	4.24	0.62	2.54*
10. The students in my class are concerned about one another	3.70	0.80	3.76	1.04	0.21
11. The students in my class smile at one another	4.20	0.70	4.33	0.58	0.64
12. The students in my class engage in small talk with one another	4.30	0.47	4.19	0.60	0.65
13. The students in my class are non-judgmental with one another	3.55	1.05	4.19	0.75	2.22*
14. The students in my class laugh with one another	4.10	0.72	4.05	0.59	0.24
15. The students in my class are supportive of one another	4.00	0.65	4.19	0.60	0.96
16. The students in my class show interest in what one another is saying	4.15	0.81	4.05	0.83	0.39
17. The students in my class cooperate with one another	4.30	0.57	4.19	0.75	0.52
18. The students in my class feel comfortable with one another	3.90	0.91	4.24	0.54	1.44

*p < .05

CCCI received very high means for the face-to-face classroom, which revealed that most of students had positive and favorable feelings toward the connected classroom climate. These findings suggested that participating in a real-world class, communicating and interacting with in person, and learning uninterrupted by outside distractions may be important factors for developing a positively connected classroom climate. These findings corresponded to Dwyer's study [7], which may indicate that students' perception of a connected classroom climate in face-to-face classrooms are more or less the same.

Although no significant differences were found between the traditional classroom and the hybrid classroom in CCCI responses, the overall mean of hybrid classrooms ($M = 4.23$, $SD = .74$) was higher than the overall mean of the traditional classroom ($M = 4.08$, $SD = .80$). These results indicate the connected climate of a hybrid classroom can be perceived equally as effective as the traditional classroom.

There was response variation identified between the traditional and hybrid classrooms on CCCI items 5, 9, and 13 (see Table 1). In these responses, students indicated a more positive perception toward the hybrid classroom as compared to the traditional classroom. Therefore, this student sample perceived the hybrid classroom as more friendly and less judgmental. However, these findings could be the result of the STEP model, rather than the hybrid course structure.

Self-reflection from students in both courses supported the CCCI survey findings of a positively perceived hybrid connected classroom climate. Some specific representative examples of the many student self-reflections are seen in Table 2.

Table 2. Students' perception of hybrid classrooms in self-reflection

ID#	Representative student responses
1	Favorite part of the class is connecting with others in the classroom and viewing each other's classwork
2	I loved this class! We were showed something new every face-to-face week and were given assignment that allowed us to gain practice in a supportive environment
3	The hybrid style works well with everyone's schedules and alleviates some of the pressure of having to go every week, so that everyone is in high spirit when they get to meet for real. I love this hybrid course because it as boring as traditional face-to-face class or as detached as an online course. I think it is a perfect combination of the two forms and I really enjoyed the classroom atmosphere throughout the course

5 Limitations and Conclusion

This study defines the hybrid classroom, discusses a best-practice model for implementation, and explores the effectiveness of connected classroom climate in respect to students' perception with the CCCI measurement. Furthermore, this study directly compares students' perception of connected classroom climate within various hybrid and traditional face-to-face classroom structures.

These findings indicate that hybrid classroom structures can be perceived by students as very effective vehicles for delivering a positively connected classroom climate. In fact, with the appropriate instructional model such as STEP, the hybrid classrooms were perceived equally to, or greater than traditional face-to-face classrooms by students. These results can serve as a framework for assisting researchers and practitioners who are designing, analyzing, and building positive classroom climates in hybrid learning structures that enhance teaching and learning.

The limitations of this study include population size and a lack of control on students' pre-conceived perception of face-to-face classroom experiences. The researchers suggest that larger samples be investigated. Additionally, future research should include a 3-group comparison between traditional, hybrid, and fully online courses, as this study only investigated and compared traditional and hybrid structures.

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Promoting Students' Engagement? Flipped Classroom Matters a Lot – An Empirical Research in College

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Abstract. Students' engagement under the traditional classroom setting still requires some improvement in domestic colleges. Many teachers want to use Flipped Classroom to improve teaching effectiveness and promote the students' engagement. This paper studies the use of flipped classroom teaching model to solve the problem. In the study, the research objects are 57 junior students enrolled in the *Modern Educational Technology* experimental class. We conduct questionnaire survey, semi-structured focus-group interview and analysis to investigate the students' engagement in behavioral, cognitive and emotional dimensions. It is found that the flipped classroom teaching method can promote students' engagement. Flipped classroom can essentially improve students' behavioral engagement. Students are also encouraged to participate more in cognitive engagement.

Keywords: Students' engagement · Flipped classroom · Higher education

1 Introduction

With the expansion of higher education, students' disengagement phenomenon is one of the most direct and continuous problems in educational practice. In many cases, students attend class and complete the work, but with little indication of excitement, commitment, or pride in mastery of the curriculum [1]. This phenomenon is common in domestic colleges. College students' disengagement in class has overtaken active engagement [2]. Xu Jing considered that the boring atmosphere of colleges' class is due to less interaction between teachers and students. Currently, the college students' engagement in the classroom is very "low" [3].

The researchers point out that problem of students' engagement is the concern of school education [5]. Students' engagement has a significant impact on the academic

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achievement [6]. To promote students' engagement and academic achievement, improving the teaching methods is of great significance.

At present, many empirical studies indicated that the flipped classroom teaching can improve the students' engagement [7–10]. However, these studies have not clearly identified what students' engagement is and students' engagement measuring method during the learning procedure.

This study aims to address the research questions: What are the aspects of the college students' engagement in the flipped classroom? What is the difference in students' engagement between the flipped classroom and traditional classroom? Why does students' engagement get improved in the flipped classroom?

2 Literature Review

As a new teaching model, flipped classroom makes the educators see the dawn of the improvement of teaching activities, and becomes a means of improving teaching effectiveness. Essentially, the flipped classroom is a new form of teaching, in which teachers provide teaching video as the main form of learning resources, and students watch the teaching videos and other learning resources and finish the learning tasks before the class [11]. They complete homework questions, collaborative inquiry and interactive activities during the class. A series of activities in the classroom will be carried out in a relaxed environment. Between students and students as well as students and teachers, there are cooperation, exchange, interactive discussion, and expression of ideas, all to complete the problem solving.

2.1 The Practice of Flipped Classroom in University Improves Students' Engagement

As early as the end of twentieth Century, some colleges and universities started to use inverted classroom to solve the problem of low class engagement. Maureen J. Lage, Glenn J. Platt, and Michael Tregli, teachers in Miami University, use the flipped classroom teaching mode in their economics class. They did a survey on students and teachers' acceptance of the flipped classroom and made a comparative study with traditional teaching methods. It is found that the flipped classroom is recognized and accepted by students and teachers, and students enjoy the freedom of pre-study and classroom discussion. The flipped classroom teaching model can help the teachers carry out differentiated instruction, provide more opportunities for students to change their learning styles, and improve their cognitive and emotional participations [5].

Jeremy F. Strayer discussed the application of flipped classroom in university courses in his paper "The effects of the classroom flip on the learning environment: A comparison of learning activity in a traditional classroom and a flip classroom that used an intelligent tutoring system". In the flipped classroom practice, he recorded video as a homework assignment for the students to watch, and organize students to participate in the project work in the classroom. The results showed that students can control the rhythm of watching the video autonomously. This promoted the students' learning initiative, thus students can participate in the classroom learning more actively. Students might produce a sense of imbalance due to the difficulty of the task and the flexibility of the activities, but this imbalance could motivate students to complete the learning task. To some students, flipped classroom could inspire them to complete the study task. At the same time, the students experienced more innovation and cooperative learning, and actively participated in learning activities [12].

Jacob Enfield verified the effect of the implementation of the flipped classroom in his study. Students' presentation and report will continue making students actively involved in the task of classroom activities. Because of the completion of pre-class learning tasks, students can achieve a certain cognitive basis and cognitive confusion which can promote students to participate in classroom learning. At the same time, the students think that through the pre class learning tasks, they are more confident to learn other content to enhance their autonomous learning ability [13].

In studying the use of the flipped classroom to promote students to participate in and improve learning, students' emotional engagement is the highest, followed by the behavioral engagement, cognitive engagement. At the same time, as compared to the students' behavioral engagement and cognitive engagement, students' emotional engagement plays an important role in the active learning in the flipped classroom. In this study, researchers believe that students are very interested in the flipped classroom at first, and then acquire new knowledge in lively and happy atmosphere, promoting their emotion of participation. In this way, students will listen to the teacher carefully, and have more patience and efforts to participate in classroom activities, namely emotional involvement promotes students' behavioral engagement [14].

In short, in the flipped classroom, students learn the resources carefully designed by teachers in advance and complete the tasks. That means students can learn with a clear goal. Students reach a certain knowledge base before class, which is conducive to the students' participation of classroom discussion, reporting, evaluation and other acts. Meanwhile, students can actively participate in the classroom to ask questions with the cognitive confusion before class [15]. Solving classroom problem is conducive to students' learning achievement that promotes the students' emotional participation. Interaction and communication encourage students to combine previous knowledge and experience to think, solve problems, and thus enhance the students' cognitive engagement. However, these studies rarely define the dimensions and concepts of student engagement. They only study the effect of flip classroom to the students' engagement from the behavioral engagement or emotional engagement perspective. It is necessary to determine the concept of students' engagement in the flipped classroom, in order to provide researchers with indepth study of the impact of the flipped classroom on students' engagement.

2.2 The Definition of the Concept of Student Engagement

Student engagement refers to the students' psychological input, especially their attention, interest, participation and efforts in the process of learning. This definition includes not only the engagement of students' learning behavior, but also the involvement of emotional and cognitive components [16].

We define the students' engagement in the flipped classroom as the combination of the three dimensions of behavior, emotion and cognition based on the definition and connotation of the concept of a number of students' engagement. The specific connotation of the definition is shown in Table 1.

Table 1. Dimensions and connotation of students' engagement

Dimensions of students' engagement	Connotation
Behavioral engagement	Whether students' behavior is active or not, including two aspects, the behavior of students in the classroom and the behavior of pre-class learning
Emotional engagement	Students' emotional experience in the teaching activities
Cognitive engagement	The learning strategies used by the students in the learning process. These different strategies cause students to participate in different levels of thinking activities

3 Research Methods and Processes

3.1 Research Context

This study is carried out in a normal university which located in southern China. The university can provide the corresponding venues and network conditions for the development of the flipped classroom activities. The college students have certain informational literacy and the independent learning ability as well as enough time. The flipped classroom can be successfully launched.

Implementation of flipped classroom was based on Chenjingzi Zhang and Xiaodong Wang's teaching procedure [18]. Before class, teachers make the micro lesson related to the teaching subject and other learning auxiliary resources, design learning guide before class, and release the task. Students watch the learning resources according to the learning guide, and complete the task before the class. Then they hand in homework in the next week before the class. The teacher corrects students' peer assessment task. During the class time, teacher review the students' homework comment and feedback activities. Students give a report on their homework. The teacher makes the summative evaluation. The group members discuss the subject matter of this course. Each group elaborates the ideas and explains the reasons. Finally, the teacher makes comments on the students' performance and discusses each team's performance with students.

3.2 Research Object

The research object is the students taking the Modern Educational Technology course. This course is basically the training of teaching techniques and skills. The students need the training on information retrieval and processing, development of teaching resources, teaching design, and so on. They need more guidance and comment from the teachers during the in-class stage, in addition to self-practice. The course fulfills the requirements of the flipped classroom teaching mode.

3.3 Research Methods

In the flipped classroom, students' engagement in learning Modern Educational Technology is investigated. The three dimensions of engagement include behavioral engagement, cognitive engagement and emotional engagement. It is difficult to use the measurement in a single way because of three aspects in students' engagement. We used questionnaire survey, interviews, and the analysis of students' homework and students' own subjective evaluation to collect the data of students' engagement.

3.3.1 Questionnaire Survey

The questionnaire survey investigated the students' evaluation of their behavioral engagement, emotional engagement and cognitive engagement according to Likert scale. The questionnaire was revised by 4–5 experts to improve the validity of the questionnaire. Randomly selected students were asked to fill in the questionnaire. A total of 57 valid questionnaires were returned. The results were compared between the two dimensions of behavioral engagement, emotional engagement and cognitive engagement. Analysis the questionnaire reliability is shown in Table 2.

Table 2. Reliability statistics

Cronbach's Alpha	Alpha Cronbachs based on the standard term	Number of items
.830	.840	13

The questionnaire is completed and the results are collected. We use SPSS test the questionnaire reliability statistics and according to the standard 0.70 $\sim$ 0.80 (very good); 0.80 $\sim$ 0.90 (very good). As the result, a questionnaire with 0.80 reliability coefficient is better, a questionnaire's coefficient is more than 0.80 is good, and this questionnaire has a high reliability and it is credible.

3.3.2 Semi-structured Focus-Group Interview

We conducted face-to-face interviews with the students, and collected the informal semi-structured focus-group interview data to further measure students' engagement in flipped classroom. At the end of the semester, we conducted group interviews (with 4 students in a group) to review the student's academic achievement and learning attitude.

3.3.3 Analysis of Homework

In order to ensure objectivity of the students' engagement data, the time of handing in homework is recorded. The records can show the percentages of those students submitting their homework on time and those submitting late. The homework was assessed in five grades. Based on the students' homework, we analyzed the students' engagement in the flipped classroom.

4 Research Results and Discussion

Comparing the statistics of students' engagement in the traditional teaching classroom with the statistics of student' engagement in the flipped classroom, the students' engagement in flipped classroom is higher than the students' engagement in the traditional teaching classroom. The statistics of student' engagement in the traditional classroom is based on Xu Zhang's master thesis [13]. It can concluded from the correlation data that flipped classroom teaching method can promote students' engagement, especially, flipped classroom improves students' behavioral engagement most. Tables 3 and 4 show the correlation statistics of students' engagement in traditional teaching classroom and flipped classroom respectively.

Table 3. Statistics of Students' engagement in traditional teaching classroom

Students' engagement	M	SD
Behavioral engagement	3.086	.713
Emotional engagement	3.338	.790
Cognitive engagement	3.315	.760

Table 4. Statistics of Students' engagement in flipped classroom

Students' engagement	M	SD
Behavioral engagement	3.578	.885
Emotional engagement	3.513	.938
Cognitive engagement	3.409	1.052

4.1 Data Analysis on Behavioral Engagement

According to the theory of time-on-task, the educational psychologist Tyler Ralph considered that the more time the students put into the study, the more knowledge they acquire [2]. This is educators' early notion of students' learning behavior participation. However, our research cannot prove this theory.

When interviewing group students from the Modern Education Technology class, we ask them how long they spend on finishing the homework during the pre-class period. Students' answers are similar. It takes roughly the same amount of time for students spent on finishing the task in the pre-class period and after-class period. However, the time for students to participate in the activities in the classroom is indeed greatly extended. Other researchers also believe that the flipped classroom enable students learn more. The students' classroom performance is more active and positive. Flipped classroom make additional time and effort more meaningful [14]. We got the same result in our flipped classroom, where students were more active according to their learning behavior we observed.

In the behavioral engagement, there are two aspects of learning, namely, serious learning and persistent learning. To some extent, students overcome the difficulties and complete the task. This shows that the depth of students' behavioral engagement in pre-class period of the flipped classroom is relatively high. During the class time, students who still have doubts about the previous pre-class learning questions asked others (the teacher or classmates) for help. This can reflect that the average depth of cognition is higher than that of concentration. This also shows that the classroom discussion activities stimulate students' thinking and questioning, which is conducive to the high level of thinking for students' engagement. Figure 1 shows the student behavioral engagement statistics.

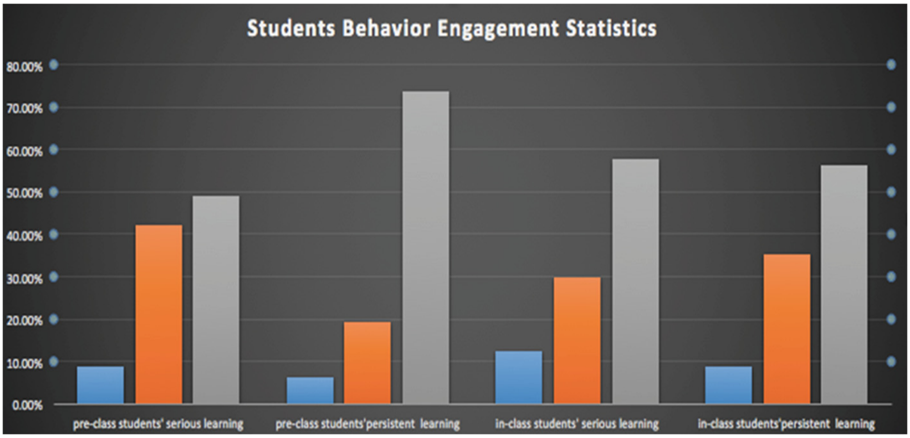

Fig. 1. Statistics of Students Behavioral engagement. The three bars from left to right presents students' low/middle/high score in each group.

The students' learning behavior in the pre-class promotes the active participation of students in the classroom. This is not clearly shown in the questionnaire data. However, during the interview, four students considered that the self-directed learning in the pre-class period provided the basis for their in-class discussion and self-report. Through the pre-class self-directed learning and in-class discussions, students are more willing to give their presentation about their team's learning outcomes. Through the presentation, students' own language skills and logical thinking ability can be enhanced. With the comments from the teacher and other peer students, students realize their own deficiencies.

4.2 Data Analysis on Emotional Engagement

Overall, students' emotional engagement in the flipped classroom teaching mode has reached to a higher level. During the learning process, students may feel anxiety about the effect of their self-directed learning in the flipped classroom. They worry that their learning effect is not good, thus affect the performance and the final score. This dimension of emotion in relatively high anxiety sense in the class is 12.28 %. That

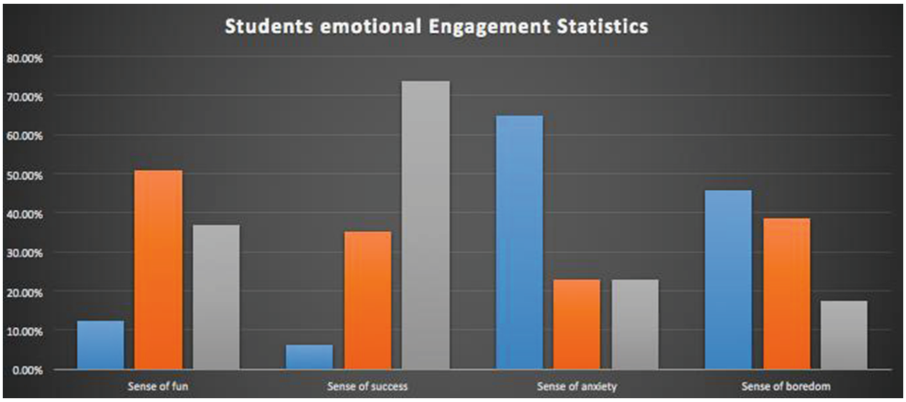

Fig. 2. Statistics of Students' emotional engagement. The three bars from left to right presents students' low/middle/high score in each group.

means the task requirements and guidance in the flipped classroom have a positive impact on the students' emotional and behavioral engagement. To a certain extent, it can promote students' learning motivations [5]. But if students study for long time in a course, it will have a negative impact on the students' engagement. This requires the teachers to give some learning guidance. In the classroom, we mainly solve the problem which cannot be solved before class. We also arrange the learning task before class as far as possible, providing guidance and high correlation assisted learning resources to reduce the students' anxiety.

The sense of achievement of the joy generating from solving the problem in the flipped classroom reaches a normal level. The high engagement is 73.69 %. This sense of achievement plays a great role for students to continue to actively participate in the completion of the task before the class and the class discussion. Students' weariness tendencies will lead to students' lower participation. It can be seen that the emotional involvement is 17.55 % for the students with weariness tendency. While for the sense of fun in the flipped classroom, the emotional involvement reaches 36.85 %. Students' sense of pleasure is greater than the weariness of the classroom teaching mode. This shows that students are willing to participate in the flipped classroom activities. Other studies also found that students' engagement for teaching emotional experience affect students' cognitive process, and positive emotions can affect students' behavioral engagement by influencing the cognitive processes of students [5]. Figure 2 shows the students' emotional engagement statistics.

4.3 Data Analysis on Cognitive Engagement

Students' cognitive engagement is mainly based on the learning strategies used by students. The survey results show that, among the three different levels of learning (shallow learning, deep learning and dependent learning), students inclined to take the deep learning strategy which links the content they learn to practical application.

Form the statistical results, we find an interesting phenomenon: The use of "dependent learning" represents an average distribution of the cognitive involvement. This is due to the learning characteristics of the dependent learning strategy. In the flipped classroom teaching process, the teaching activities are in line with the characteristics of college students' learning strategies. Therefore, students have the enthusiasm to participate in the classroom teaching activities. In the interviews, 3 students mention that they will use their learned and recognized knowledge and methods. In response to the "whether it will feel anxious or not if encounter problems which will not be done before class", the student replied, "I do not feel anxious, because we can ask the teacher in the classroom, and the teacher will explain very clearly". To some extent, the middle school students' dependence on the teacher will be bigger. This shows that it has a positive effect on the students' participation when teachers provide effective support and feedback on students' participation [17]. The flipped classroom is more conducive to the students who have strong ability of independent study, and it can promote the application of their deep learning strategies, thus cultivating students' higher order thinking ability.

For the dependent students, classroom time is used to discuss and solve problems encountered in the flipped classroom teaching course. Therefore, students can solve the problem in the classroom. This happens to help the teacher to provide guidance for students, enhance the students' learning interests, and motivate them to participate in a more active way in the future. Figure 3 shows the students' cognitive engagement statistics.

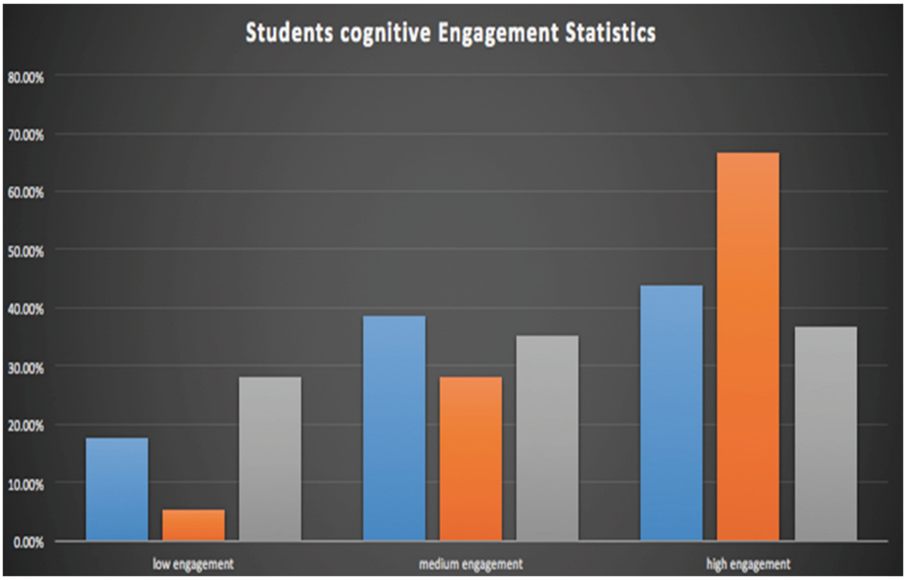

Fig. 3. Statistics of Students' cognitive engagement. The three bars from left to right presents students' low/middle/high score in each group.

5 Conclusion

It is concluded that flipped classroom teaching method can promote students' engagement, especially the students' behavioral engagement.

Based on the results, it is found that flipped classroom not only encourage students to acquire knowledge and change learners' learning behavior but also constructively influence the students' learning emotional experience and students' cognitive style. Students' behavioral engagement, cognitive engagement and emotional engagement are not only important study variables but also learning outcomes. These affect the students' emotion, learning attitude and cognitive style. Most importantly, students can benefit from the positive learning attitudes. This study also discovers that the flipped classroom influences students' emotional engagement most. Students learning problems in the pre-class period can be solved or get feedback in time from teachers or classmates. Through the in-class presentation and discussion activities, there are more opportunities for interaction between students and teacher as well as between students and students. The focus is placed on enhancing the students' knowledge and critical thinking.

All these have positive influence on students, where the students' cognitive style and cognitive participation can be improved.

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Metamodel for Evaluating the Performance of ICT in Education

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Abstract. Performance evaluation is an effective way to promote the sustainable development of ICT in education. Current researches pay little attention to the "meta" layer of how ICT is applied into education, only concentrating on its level evaluation or one-off static evaluation and leaving its continuous enhancement or sustainable development behind. This paper simplifies the whole performance evaluation framework by means of "meta" ideology, and finally extracts four core elements according to performance theory and metamodeling technology, i.e. performance evaluation dimension, performance evaluation item, performance improving trail, and performance relation. Upon the performance evaluation metamodel of ICT in education is proposed, then followed by its metamodel architecture. The metamodel and its architecture as a whole give a solid, theoretical support and guidance to the construction of performance evaluation model (and the criteria or indicators) in practice. In addition, this metamodel in the highest level provides a general and unified specification for many existing models in this field, enabling a common, clear and unambiguous description of these models. As a result, these existing models and indicators (and some others to be proposed) can be explained, interpreted or understood under the same framework.

Keywords: ICT in education · Performance evaluation · Metamodel · Indicators for evaluating ICT in education

1 Introduction

Nowadays, ICT (Information and Communication Technologies) has been rapidly and widely introduced in Education, from pre-school education to higher education or even lifelong education. ICT is considered crucial to enhance the quality of education, especially in developing countries. China, for example, has invested enormous manpower, material resources and financial resources into every level of education, judging from government and entrepreneur perspective. Up till now, the infrastructure is well constructed, and all kinds of educational applications are running on it regularly. Moreover, the integration of IT and curricula seems reasonably tight enough to satisfy most education needs – we can just draw a full stop by simply putting all the courses and resources online. Rapid development of ICT and its massive use in education form a whole education chain: government, companies, teachers, students, parents, researchers

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and even critics get involved in this trend, so much so that they all share the same risks, profits and benefits. These stakeholders [1], together with the infrastructure, curricula (or courses), resources, educational products (e.g. e-school bags, learning platforms, etc.) give birth to a new term called Education Informatization. Though it is not globally used, this term grasp the kernel and almost all aspects of ICT in education, which will be used hereinafter to represent e-education when applying ICT into education if it is proper and doesn't lead to misunderstanding.

However, the huge investment of ICT in education didn't seem to be always rewarding. In the early 21st century, many people criticized some impulsive investment pouring into education with little effect, though new changes could be actually found. Lack of matched effects caused a tremendous discrepancy in measuring the input and output of ICT in education. In order to recognize the actual situation of Education Informatization, leverage the investment and improve its sustainable development, more and more people started to resort to performance evaluation to measure how ICT was applied into education, which helped to transform one-off static evaluation into a dynamic one. Besides, schools and universities have been placing increasing emphasis on improving the quality of their educational services with the availability of new technology and the Internet, in order to enhance the quality of education. After all, Education Informatization is still in its infancy with a long way ahead, which entails a more effective evaluation to lead it to a new, comprehensively innovative stage. Accordingly the exploration of new theory or methodology in performance evaluation has become a basic and principal foundation for evaluating the effects of ICT in education.

Related works in this field mainly concentrated on research framework, analysis pattern, evaluation model and evaluation indicator about how ICT was applied into a certain level of education (e.g. elementary) or a certain area of educational practice (e.g. south-east Education Informatization), as will be discussed in Sect. 2. They all relied on a specific performance evaluation model or indicator system that was created for that purpose. Unfortunately no existing research gave a general, systematic view of how to guide and evaluate the effects of ICT in education, especially from the "meta" layer point of view. Here "meta" means upper, on the top of, or even supreme, which emphasizes the description of how to make an instance model (refers to performance evaluation model, in this paper). It is the model of the instance model(s) and stands on the top of any instance model(s) in hierarchical architecture. From a top-down perspective, it was this lack of commander that weakened the effects of most of the existing works. As they paid too much attention to the current situation of ICT in education, which seemed one-off static, without enough concern about its continuous improvement and sustainable development. In fact, these two are more dynamic and may probably be the most critical step to take when evaluating the long-term effects of ICT in education. While from a bottom-up perspective, different people created different evaluation models or indicator systems for different purpose using different methods from different dimensions, and got different results consequently. This paper argues that there are some common and indispensable factors or key points that these existing models and indicator systems share. In other words, there are some elements /features that exist as key components and constitute the core of evaluating ICT in education. To this end, this paper simplifies the whole performance evaluation framework by means of "meta" ideology, and finally extracts four key elements according to performance theory and metamodeling technology. Upon that the performance evaluation metamodel (PEM) of ICT in education is proposed, then followed by its metamodel architecture (PEMA). PEM and PEMA as a whole give a solid, theoretical support and guidance to the construction of performance evaluation model (and the criteria or indicators) in practice. In addition, this metamodel in the highest level provides a general and unified specification for many existing models in this field, enabling a common, clear and unambiguous description of these models. As a result, these existing models and indicators (and some others to be proposed) can be explained, interpreted or understood under the same framework.

2 Related Works

Begun in 1990, the Campus Computing Project (CCP) was the largest continuing study of the role of computing, information technology, and eLearning in American higher education. The project's national studies drew on qualitative and quantitative data to help inform faculty, campus officials, policy-makers, and others interested in a wide array of information technology planning and policy issues that affected colleges and universities in the United States [2]. It was considered as the earliest research in this field. In 2001, CEO forum on Education and Technology in America produced STaR (School Technology and Readiness) evaluation system, including four dimensions, i.e. hardware and network connectivity, professional development, digital resources, and student achievements as well [3]. In 2005, the World Bank made a research in some of the developing countries to evaluate the application of ICT in education from ten aspects, including the influence of ICT to students' learning and achievement, investment in education, and the like. These ten aspects could be categorized into four themes: influence, investment, application and planning of ICT in education [4]. International Telecommunication Union (ITU), United Nations Conference on Trade and Development (UNCTAD), United Nations Educational, Scientific and Cultural Organization (UNESCO), together with dozens of international organizations formed a partnership on measuring ICT for development and began to design and release core ICT indictors. There were nine educational ICT indicators in "Core ICT Indicators 2010" [5]. In 2006, British Educational Communications and Technology Agency (BECTA) released the Self-Review Framework (SRF) to evaluate the ICT development and application level of a school [6]. The revised version of 2010 included six dimensions: leadership and management, planning, learning, ICT proficiency evaluation, professional development and resources. In 2008 "ICT in schools" was published by Department of Education and Science, where the ICT planning matrix was designed to help schools establish their level of development with regard to the use of ICT. There were five categories involved: management and planning, ICT and the curriculum, professional development of staff members, school's ICT culture, and ICT resources and infrastructure as well. For every single category there were sub categories of three levels: initial, intermediate or advanced [7]. Pan-Canadian Education Indicators Program (PCEIP) was created with the goal of developing a set of statistical measures that would provide information on education systems in Canada [8]. The indicators contained student-computer ratio, bitrates of network connection, student activity through Internet, and existing barrier of applying IT, etc. In 2010, Katerina K. proposed a conceptual framework for evaluating ICT in education, which covered several domains: policies, resources, curriculum, organization, teaching and learning [9]. Apart from these mentioned above, Asian countries like Japan and Korea also joined in this research area. For example, Japanese evaluation for ICT in education included project investment, infrastructure, resource design and sharing, teacher, students, etc. Whereas Korean evaluation consisted of infrastructure, applying IT in teaching and learning, applying IT in administrative affair, construction of information database for teaching, learning and academic research, etc. China, as a developing country, also paid much attention to ICT in education and corresponding evaluation indicators. In 2001, Chinese Ministry of Industry and Information Technology proposed scheme of national informatization index. In its 2013 version several indicators were added, e.g. Internet accessibility, ways of accessing Internet, tablet-PC for teaching, etc. Many provinces and cities released corresponding indicators for their administrative regions according to practical needs.

In recent years, performance evaluation of how ICT is applied into education has become a popular issue, ranging from research framework and analysis pattern to evaluation model and evaluation indicator. The enGauge framework co-designed by North Central Regional Educational Laboratory (NCREL) and North Central Regional Technology Education Consortium (NCRTEC) of America indicated six aspects when assessing the effectiveness of ICT in education [3]. Nicol D. and Coen M. proposed an INSIGHT model to evaluate ICT in higher education from cost-benefit point of view [10]. Laurillard D. proposed a benefits-oriented cost model for technology enhanced learning [11]. Zapata C.B. and Rojas H. proposed and validated ways of assessing appropriation of ICT in higher education, where endogenous and exogenous factors were organized in pyramidal style [12]. Eva M.C. proposed a performance-evaluation model to select the dimensions and items of questionnaire that required improvement to achieve student satisfaction and continuous improvement [1]. Wang H. established a performance evaluation metamodel and related indicator system based on effect, efficiency and effectiveness (EEE) of how ICT was used in elementary education [13].

The above researches made a great contribution to the development of evaluating ICT in education theoretically and practically. There were many other models or indicator systems that were not mentioned here, and they effectively solved a certain kind of problems when evaluating ICT in a certain type of education. However, few of them regarded the evaluation as a whole, nor did they consider at “meta” level. Although [13] talked about metamodel, it is not meta at all from metamodeling angle – the so-called metamodel in [13] only applied to its evaluation model instead of interpreting other existing models, and it was too concrete and specific to do so. Furthermore they paid little attention to the continuous and dynamic enhancement of ICT performance in education.

3 The Construction of PEM

3.1 Theoretical Foundation

Performance originated from company and was considered as behavior tendency and achievement in accordance with the overall goals and value pursuit of an organization [14]. It was composed of two aspects: behavior and value. It was a comprehensive reflection of processes and results. When applied into education, it became unstable since the result of education was extremely difficult to calculate and evaluate. Some authors introduced 3Es to help solve this problem, where 3Es were effect, effectiveness, and efficiency respectively [15].

This paper takes the initiative to resorting to metamodeling technology used in Software Engineering from another angle. Metamodel, a principal concept in metamodeling technology, is a description of how to establish a model, what the semantic is, and how to integrate and interoperation among models. Metamodel is a higher-level abstraction from model, which captures the basic attributes and behaviors of models and is regarded as the foundation of model construction. In Model Driven Architecture (MDA), one of the OMG, Inc. (Object Management Group) specifications, there are three models: meta-metamodel, metamodel, and model [16]. Each of them represents a certain model in a certain layer of Meta Object Facility (MOF). Specifically, model in M3 layer (the highest layer) is called meta-metamodel; model in M2 layer (a lower layer under M3) is called metamodel; model in M1 layer (a lower layer under M2) is called model; and instance in M0 layer (the bottom layer).

3.2 Principals of Construction

First of all, metamodel should be simple and abstract enough. Model is a descriptive result of the feature and behavior of a thing by means of a certain description language. In other words, model is the abstraction of a specific object, which means the exclusion of many details to be revealed when the model is instantiated. Being the abstraction of a model, metamodel should be simple and abstract enough. That is to say, if the proposed metamodel turns out to be complicated, it is not an ideal result.

Secondly, metamodel should own adequate descriptive ability, so that models can be derived from it. As a tool to describe things in the real world, model should be able to capture attributes and behaviors of the object being modeled. That is to say, a model should have the ability to describe syntax and semantics of its instances. Being a model, metamodel should be expressive enough to describe (derive) not only the existing models but also models to be built in the future.

3.3 Core Elements of PEM

1. Performance evaluation dimension

The performance of ICT in education is difficult to measure because it is a multi-input, multi-output and dynamically developing process where many implicit and coupled factors exist. Many researchers advocated dealing with this problem by 3Es dimensions (effect, effectiveness, and efficiency as mentioned above), resulting in an evaluation divided into effect evaluation, effectiveness evaluation and efficiency evaluation [13]. Other researchers argued different dimensions, such as ecological dimension [17]. In this paper, performance evaluation dimension is extracted to represent a single viewpoint, a multi-aspect (multi-level) condition and concept used to judge and evaluate the performance of ICT in education. It directs the way the evaluation goes to and exists as a decisive and macro factor. Note that, a dimension can be divided into several sub-dimensions.

2. Performance evaluation item

Evaluating performance of ICT in education requires huge efforts and numerous aspects, which can normally be divided into six sub-items: infrastructure, resources, educational application, staffs, informatization industry and policy. Note that any other division is possible in condition that it is practically feasible. And if it is needed, all the subs can be divided into sub-subs, sub-sub-subs, etc. In this paper, performance evaluation item is extracted to represent the sub (also sub-sub, etc.) that actually exists in almost all current models or indicator systems. As a result, performance evaluation item refers to a specific evaluation aspect and exists as a micro factor.

3. Performance improving trail

Education Informatization is a dynamic, progressive process that is characterized by non-static, step-by-step, and ever-growing. Accordingly its performance evaluation should be a routine (not one-off) and continuous process to get better results, aiming at promoting sustainable development and raising the quality of teaching. To this end, this paper proposes an element called performance improving trail to represent the progress or path that the whole performance undergoes.

4. Performance relation

In any performance evaluation models or indicator systems, there must be some performance relations. For example, to divide an item into sub-items, or to categorize some items into a certain dimension. In most of the practice, there are always some relations that are customized under a specific circumstance, which are rather dependent on practical needs. For example, dependency relation, generalization relation or extension relation. As a metamodel, this variable element should be captured. Due to the uncertainty of what a relation refers to in practice and how it is linked with other elements, this paper extracts performance relation to represent any customized relation that may occur. Therefore it would be more natural and simple to deal with all kinds of unforeseeable relations, without loosing any expressive power.

It is easy to see that the subordination relation between an item and its sub-item is captured by this element, so that one single element “performance evaluation item” is enough in PEM, without any need to introduce “performance evaluation sub-item”.

3.4 Performance Evaluation Metamodel Architecture (PEMA)

Like any other models in MDA, metamodel itself should be described by another model, which is called meta-metamodel. Meta-metamodel is a model of any metamodel, and exists as a brain in the whole architecture. It is self-descriptive and regarded as a closure in Math. It is the existence of meta-metamodel that enables us to describe all metamodels, models and instance models in the same way.

Figure 1 shows a four-layer metamodel architecture for performance evaluation, called performance evaluation metamodel architecture (PEMA). It is complete and self-descriptive. Each element in a certain layer corresponds to an element in the upper layer rigorously. Each layer is an instance of the upper layer and the abstraction of the lower layer. In other words, it is an instantiating process from top-down angle, while an abstracting process from bottom-up. As the case of evaluating the performance of ICT in education, M3 layer (meta-metamodel layer) only contains "performance evaluation object", a single element used to describe elements of M2 layer. M2 layer (metamodel layer) contains four elements, which are exactly those in PEM and used to describe elements of M1 layer. M1 layer (model layer) represents all possible evaluation models and indicator systems (not limited to those mentioned in Sect. 2). M0 layer (instance layer) refers to real data in practice, such as some infrastructure-related data (bandwidth, bitrates, etc.) in a certain scenario.

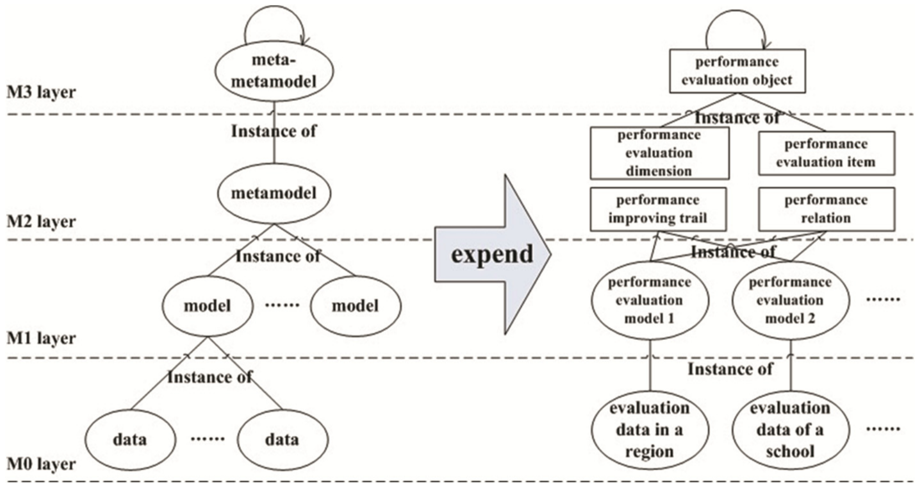

Fig. 1. Performance evaluation metamodel architecture

4 The Usage of PEM and PEMA

4.1 Describing the Main Process of Evaluating the Performance of ICT in Education

According to [18], a complete performance evaluation consists of evaluators, participants, constraints, indicator system, data collecting method, evaluation model, and evaluation benchmark. Here is the main process: according to a certain evaluation goal, the evaluators evaluate the performance (behavior and result) of a certain candidate (the object being evaluated) during a certain period of time by means of some methods by a certain performance model or indicator system. Under the PEMA architecture, the above process can be described clearly and vividly as Fig. 2.

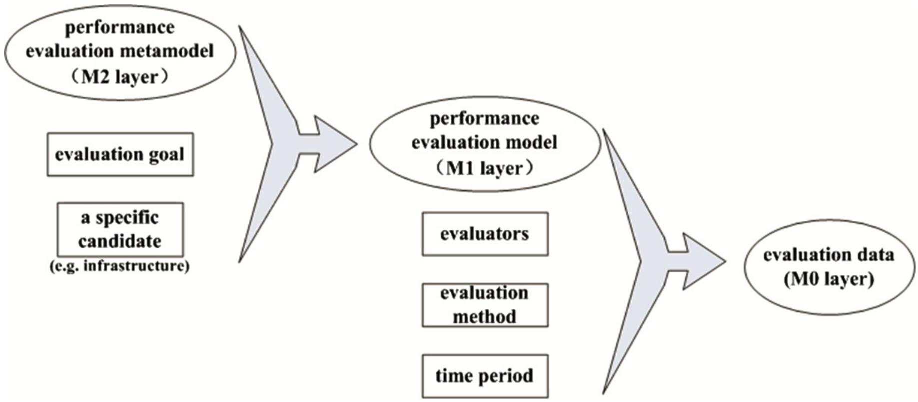

Fig. 2. The main process of performance evaluation under PEMA

4.2 Deriving Performance Evaluation Model

Only when a metamodel is instantiated precisely can it be proved to be effective and useful. In order to verify it, this paper takes two existing models as examples and tries to instantiate the metamodel into models as follows.

Example 1. Jiang D.X.'s performance evaluation indicator system.

In [18], the author decomposed items in related to how ICT was used in education and got several indicators and sub-indicators. Via dimension analysis they got sub-sub-indicators and sub-sub-sub-indicators and built the whole performance evaluation indicator system upon that. For lack of space, this paper picks up the indicator "Career Development" and describes it by PEM as Fig. 3.

In Fig. 3, "performance for career development" is the only performance evaluation dimension, and "subordination relation" (denoted by an arrow without a line, and the arrow pointing to "father" of the relation) is the only performance relation. Others denoted by rectangle are all performance evaluation items, such as talent training, scientific research, amount, ability promotion, etc. There is no performance improving trail in this case.

Example 2. Xie Y.G.'s performance and development stages of Education Informatization in rural areas.

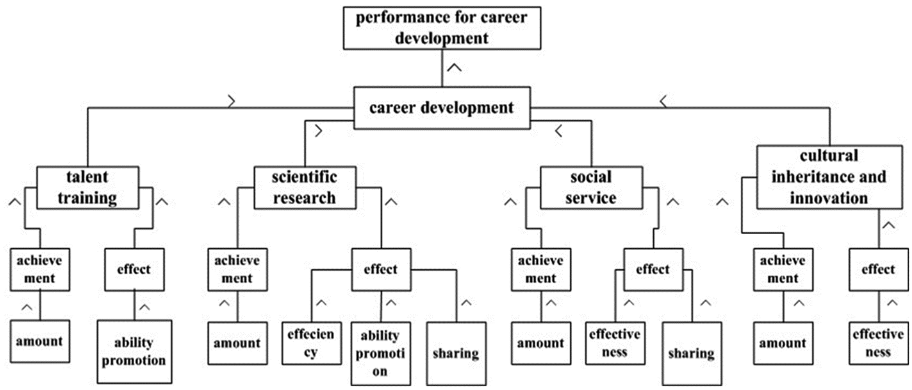

Fig. 3. Performance evaluation model described by PEM for Jiang D.X.'s indicator system

In [15], the author introduced the meaning, structure and examination content of Education Informatization in rural areas. Upon that four phases were proposed for its performance and development processes. The performance evaluation factors in her model can be described by PEM as Fig. 4.

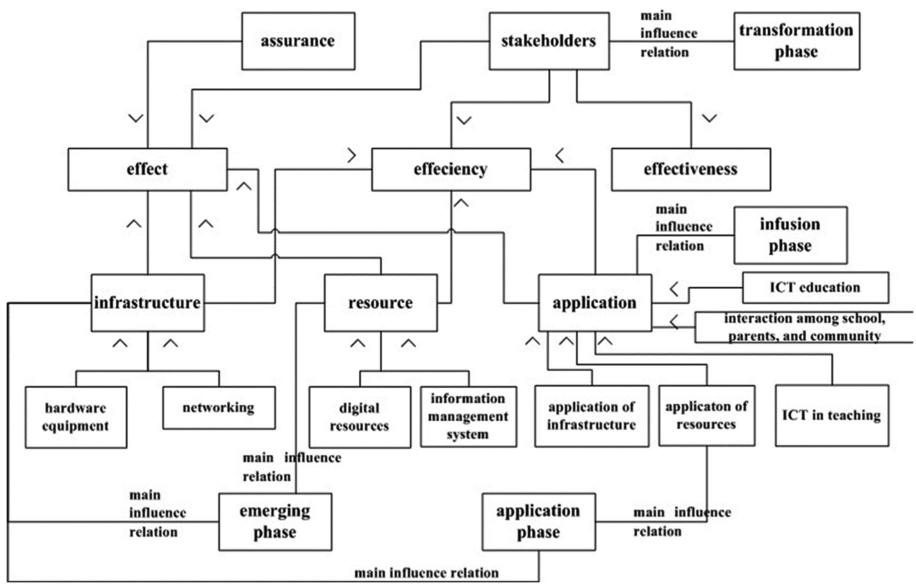

Fig. 4. Performance evaluation model described by PEM for Xie Y.G.'s model

In Fig. 4, "effect", "effectiveness", and "efficiency" are three performance evaluation dimensions, while "emerging phase", "application phase", "infusion phase" and "transformation phase" are four performance improving trails. Others denoted by rectangle in Fig. 4 are all performance evaluation items, such as infrastructure, hardware equipment, digital resources, etc. In this case, there are two performance relations: "subordination relation" denoted in Fig. 4 by an arrow without a line (likewise the arrow points to "father" of the relation), and "main influence relation" – a customized relation in Xie's model.

These two examples are representatives of the existing works. To be exact, Example 1 has nothing to do with performance improving trail while Example 2 does. By this criterion, many existing models or indicator systems can be categorized into two groups. For example, those proposed by [19, 20] fall into Group 1 (without performance improving trail) if described by PEM similarly, while those proposed by [9, 21, 22] fall into Group 2 (with performance improving trail). For instance, Fig. 5 shows some illustration of the framework in [9] (for lack of space, we only give a small portion as an example), where: "Resources" and "Levels" are two performance evaluation dimensions; "Macro", "Meso" and "Micro" are three sub-dimensions of "Levels"; "ICT availability" is a performance evaluation item with four sub-items; "Emerging Stage", "Applying Stage", "Integrating Stage" and "Transforming Stage" are four performance improving trails; apart from the "subordination relation", there is an unspecified relation that [9] did not mention.

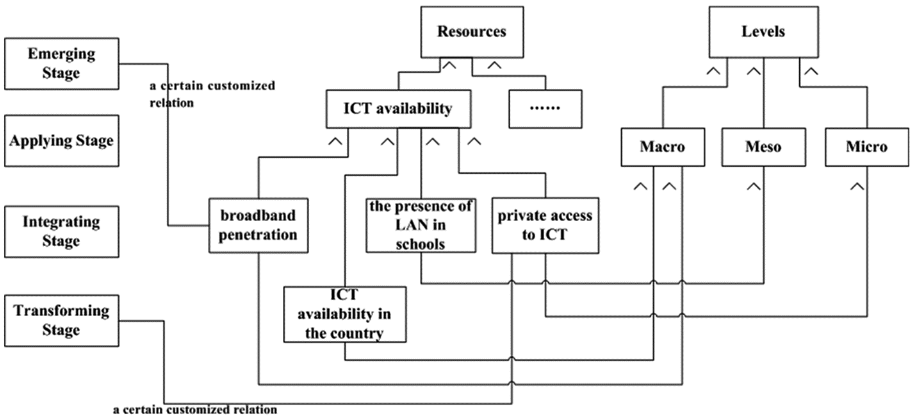

Fig. 5. Performance evaluation model described by PEM for Katerina's framework

5 Conclusion

Performance evaluation is an effective way to promote the sustainable development of ICT in education. This paper simplifies the whole performance evaluation framework by means of "meta" ideology, and finally extracts four core elements according to performance theory and metamodeling technology. Upon that the performance evaluation metamodel (PEM) of ICT in education is proposed, then followed by its metamodel architecture (PEMA). PEM is simple but with robust expressive power, and independent of any evaluation instances in practice, which fulfills the principals stated in Sect. 3.2. It is these merits that make PEM a theoretical foundation, serving as a commander at the top of performance evaluation (though meta-metamodel is the highest, it is mainly used in the closure theoretically, which seems practically useless). Thanks to PEM which makes it easy to take steps during the course of practical evaluation (as is illustrated in Sect. 4.1), just like adding additional branches into a stub. Last but not least, PEM embraces performance improving tail, the only dynamic component in PEMA that was always ignored by related works. In fact, it is crucial to the progressive enhancement of performance.

PEM and PEMA as a whole give a solid, theoretical support and guidance to the construction of performance evaluation model (or indicators) in practice. They give a skeleton and rules to conform to when constructing a performance evaluation model, and the built-in extensibility mechanism makes it possible to build a flexible and unique model according to different practical situations. That is to say, they serve as a commander of a troop by providing top-level design to guarantee the right direction, or otherwise would be a mess out of control. In addition, PEM in the highest level provides a general and unified specification for many existing models in this field, not only enabling a common, clear and unambiguous description of these models, but also ensuring the soundness and completeness of constructing a specific evaluation model. As a result, these existing models and indicators (and some others to be proposed) can be explained, interpreted or understood under the same framework, which also helps to eliminate misunderstanding or ambiguity that may cause.

To sum up, it is PEM and PEMA that help to get a better control by dominating the general ideas and instructions during the course of a all-consuming evaluation practice, while on the other side leaving room for flexibility in constructing specific /concrete models for certain practical aspects. That's exactly what a metamodel means and how it values in the hierarchy. All these contribute to giving a theoretical support and guidance to the construction of performance evaluation model and indicator system (if any), producing a scientific instruction and accurate evaluation about how ICT is applied into education, to what extent its application is, and how to improve its effects, and ultimately enhancing the quality of education.

Note that PEM and PEMA are some preliminary results and need to be upgraded continuously. We hope they both have positive referential values to the research in this field.

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Pedagogical and Psychological Issues

Blended Learning: Beyond Technology to Pedagogical Structure Design

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Abstract. Blended learning has become a predictable trend of educational revolution. However, if it is still simply understood as the combination of face-to-face instruction and online learning, such overemphasis on technology will conceal its real mechanism. According to the System Science, structure is the decisive factor for function. Pedagogical structure is the approach or sequence of the spatial and temporal combination and interaction of different elements (e.g. student, teacher, teaching content and media) in a pedagogical system. It is a mutual attribute of different levels of pedagogical system, and depends on elements' category, number, proportion, and combination modes. The current research on education revolution seldom involves combination modes between different layers of structure which is actually what blended learning aims to. Based on Jacobson's work, a revised framework of Sequencing Pedagogical Structure (SPS) was put forward by adding two more factors: emphasis of approaches and temporal orientation. It further concluded eleven structure sequences of blended learning system helping address the key issues like "to blend or not to blend" and "what extent to blend". Finally flipped classroom, a typical blended learning model, was briefly analyzed from a perspective of SPS framework.

Keywords: Blended learning · Pedagogical structure · Educational revolution · Teaching model · Teaching strategy

1 Introduction

Blended learning has become the common development trend of higher education and elementary education [1, 2]. The international research on blended learning started from 1998, but has always been in a downturn until 2007 [3]. Its popularity is mostly stimulated by the information technology and reflection on e-learning. According to American ministry of education, blended learning was the most effective learning approach compared with online learning and pure face-to-face learning [4]. Many scholars are also optimistic with the potential of blended learning [5, 6]. Why can blended learning have better learning effect? What's the internal mechanism of it?

Blended learning is typically defined as the combination of face-to-face learning and online learning due to the benefits from the development of technology. This definition takes technology (mainly network technology) as the indispensable part of blended learning. However, such overemphasis on technology will obscure people's

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understanding of the real mechanism of blended learning and make people easily trap in an educational fad. There have been similar lessons in history. For example, don't explain the instructional studies adopting different media as the influence of media itself because the result will change with different teachers, different instructional contents and other variables [7]. Lots of empirical studies and some meta-analyses proved the advantage of blended learning, but "such advantage is possibly not due to online media but the combination of multi factors which promote learners' deeper participation in instructional system" [8]. Therefore, it seems clear to narrowly define blended learning as the combination of face-to-face learning and online learning. Yet it does not touch the internal mechanism of blended learning and consequently is impossible to make blended learning lead the real educational revolution.

Apart from the narrow definition in the information age, a broad and deep perspective is necessary to understand blended learning. There have already been kinds of broad understandings of blended learning. For example, according to Singh and Reed [9], "blended learning focuses on optimizing achievement of learning objectives by applying the 'right' learning technologies to match the 'right' personal learning style to transfer the 'right' skills to the 'right' person at the 'right' time". Blended learning involves combining or mixing modes of web-based technology, combing various pedagogical approaches, combining any form of instructional technology with face-to-face instructor-led training, and combing or mixing instructional technology with actual job tasks [10]. Such understandings make the concept of "blended" too abroad to guide the specific practice. Thus this study puts forward a pedagogical structure perspective which can provide both profound and operational guidance for blended learning design.

2 The Concept of Pedagogical Structure

In China, pedagogical structure is a conception initially put forward by He [11]. It was a little controversial at first due to its ambiguity with teaching models. Further analysis of pedagogical structure and its comparison with other relevant concepts will be given from a perspective of the System Science in this part.

2.1 Structure and Function

Though discussions on pedagogical structure are still relatively few, the attention on "structure" is quite a lot in the field of education informed by achievements in the System Science. "Structure" and "function" are two key concepts of the System Science. Structure links system and elements, while function links system and external environment [12]. According to Bertalanffy [13], structure is defined as "the order of parts", that is, the approach or sequence of the spatial and temporal combination and interaction of different elements in a system; function refers to "the order of process", namely, the order of the interaction process between system and external environment. Function can be further classified into meta-function (i.e., the function of isolated element), inherent function (i.e., the mechanical sum of the function of isolated element in different numbers), and structured function (i.e., the function formed by structure.). The function of an object is thus the inherent function plus structured function. With fixed category and number of elements, the object's function depends on the structure. Therefore, research on "pedagogical structure" can inform fundamental educational issues including educational concepts and educational theory. Additionally, "research on 'process' is the starting point to construct education theory mansion", while "the main process of school education is the pedagogical process whose basic organization is pedagogical structure". "Research on technology-supported pedagogical structure is the origin of educational theory construction" [14]. Thus, from a perspective of educational philosophy, "pedagogical structure" is also the key issue.

2.2 Levels of Pedagogical Structure

Each pedagogical system has a structure and each is shown as a specific procedure of teaching activities. The structure of pedagogical system is thus the structure of pedagogical process which can be abstracted at different levels. Firstly, teaching model is a kind of model designed according to specific teaching theory to fulfill specific teaching objectives [15]. It is the combination of two or more teaching strategies or teaching approaches [16]. Teaching strategy refers to the approaches or skills adopted in the teaching process to achieve the teaching objectives and finish the teaching tasks [17]. Teaching strategy and teaching approaches return to specific teaching activities [14], which further resolve into different elements of pedagogical system (e.g. student, teacher, teaching content and media). Therefore, pedagogical structure is not an entity concept but an attribute of the system. Teaching model, teaching strategy, teaching activity, as well as each element of the pedagogical system can be taken as different levels of system which means they all have specific structures. The concept of pedagogical structure should be defined at different levels. In addition, structure is relatively stable and in order. Different structures can form a development series from a lower level to a higher level with increasing complexity [12]. Therefore, the complexity of structure depends on not only the organization of different elements but also the combination modes of structures at different levels, namely the so-called parallel and vertical structures. For example, the complexity of teaching model structure is up to the space-time combination and interaction of different teaching strategies. That is, the pedagogical structure of teaching model is the space-time function of teaching strategy.

Based on the above discussion, pedagogical structure can be defined as:

Pedagogical structure is the approach or sequence of the spatial and temporal combination and interaction of different elements (e.g. student, teacher, teaching content and media) in a pedagogical system. It has different levels with different complexities. For example, it can be shown as the structure of teaching model in a macroscopic view, the structure of teaching strategy/approach and teaching activity in a middle level view, and the structure of each element in a microscopic view.

The E-R (entity-relationship) diagram in software engineering provides a good approach to display entity type, attribute and relationship. The comparison among teaching models, teaching strategies, and pedagogical structure can be clearly depicted with such diagram (see Fig. 1), in which rectangle represents entity, oval represents

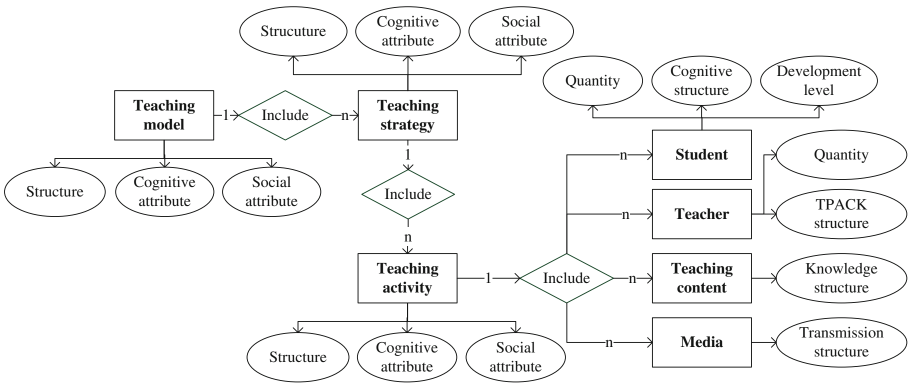

Fig. 1. E-R diagram of different levels of pedagogical system

attribute and diamond represents relationship. Relationship can be further divided into one-to-one relationship (1: 1), one-to-more relationship (1: n), and more-to-more relationship (m: n).

3 The Aim of Blended Learning: Construct Appropriate Pedagogical Structure

3.1 Impact Factors of Pedagogical Structure

The aim of blended learning is to achieve the combination strengths, that is, to absorb the strengths of different teaching models/strategies/approaches for specific teaching objectives and teaching contents and then construct appropriate pedagogical structure to promote better learning. In order to clearly show the specific impact factors of pedagogical structure, a three-level structure including teaching model, teaching strategy/approach and pedagogical system elements is thus analyzed. The relationship between levels is shown as (1).

$$\begin{aligned} PS(\text{teaching model}) &= f_1(\text{teaching strategy/approach, time, space}) \\ &= f_2(\text{pedagogical system elements, time, space}) \end{aligned} \tag{1}$$

Here PS represents “pedagogical structure”. f_1 and f_2 refer to different functions.

The expression forms of structure includes: quantity and proportion relationship, spatio-temporal relationship and mutual combination approaches [18]. Accordingly, the impact factors of pedagogical structure can be summarized in Fig. 2.

The existing discussions on educational reform have already covered the category of elements (e.g. adding the media element), the quantity of elements (e.g. the popularization of MOOCs), the proportion of elements (e.g. constructivism), and mutual combination approaches between elements (e.g. the integration of information technology and curriculum, connectivism). However, the discussions seldom involve the

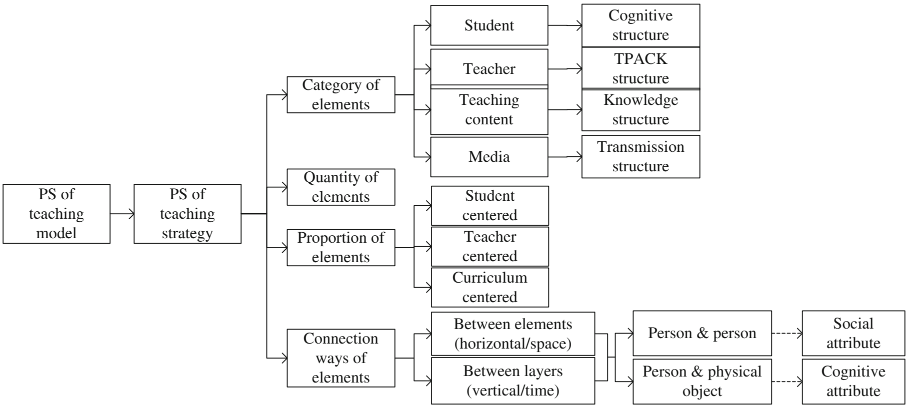

Fig. 2. Impact factors diagram of pedagogical structure

mutual combination between different layers which contributes a lot to the structure complexity. For example, how to select and combine different teaching strategies according to teaching needs. This, however, is the key of blended learning design. Thus more attention should be paid to the research on the mutual combination of structures at different levels.

4 Sequencing of Pedagogical Structure (SPS)

Jacobson and Kim [19] put forward a SPS framework to categorize different sequencing structures for learning and problem-solving activities. Such SPS framework characterizes two different structures, one is high structure referring to direct instruction approaches, typically a lecture; the other is low structure referring to the minimally guided approaches. Different sequences of structure in teaching practice were further proposed including high-to-high (HH) structure, high-to-low (HL) structure, low-to-low (LL) structure, and low-to-high (LH) structure. His preliminary empirical research has already demonstrated that the learning effect of LH structure is significantly better than HH structure. Jacobson's classification of teaching approach structure mainly focuses on the "guidance" available for students, which is similar with the two categories of "direct instruction" and "constructivism instruction". A pedagogical structure perspective helps reveal that the real value of technology for blended learning design lies in supporting different pedagogical structures. Different kinds of technology have different advantages for different types of pedagogical structure because they have different information transmission structures (see Table 1). The real reason why blended learning is more advantageous in some empirical studies is that the online learning part helps break the traditional sequence of pedagogical structure. Blended learning design guided by the SPS framework can bridge the theory and practice, helping address the key issues such as "to blend or not to blend" and "what extent to blend".

Table 1. Structural characteristics of teaching strategy and media technology

	High structure (direct instruction)	Low structure (constructivism instruction)
Teaching strategy/approach	Lecture Worked examples/Working sheet Questions/Enlightenment Demonstration Test …	Constructivism Experience learning Reflective learning Discovery learning/Exploratory learning problem/Project/Design/Computer models based learning …
Media technology	Video/Flash/Simulation, PPT/Projector; e-Textbooks; Online knowledge database; Digital library …	Computer modeling; Educational games; Concept map; Interactive white board, Communication tools; Virtual community …

SPS framework, however, just provides a high-level perspective for the research on pedagogical structure and the design of blended learning. It is still somewhat abstract and lack of some important factors, for example the duration of each phrase [19] which can also affect the element's proportion. How to allocate the class time is very significant in practical instruction. Therefore, it is necessary to consider the weight of two kinds of teaching strategy. Furthermore, adopting them simultaneously is also very common in the individualized learning environment. For example, teacher offers individualized instruction or demonstration in the process of collaborative learning.

Jacobson's SPS framework is thus further developed. As shown in Table 2, revised SPS framework retains the two categories of high and low structure, but adds two new factors: emphasis of approaches (revealed through the duration of each phrase) and temporal orientation (i.e., concurrent or sequential).

Table 2. Revised SPS framework

	Concurrent	Sequential
Equal status	①L + H	④H → L ⑤L → H
Dominant status	②l + H ③L + h	⑥H → H ⑦H → l ⑧l → H ⑨L → L ⑩h → L ⑪L → h

Note: Capital letters *(H, L)* mean being dominant, while lower-case letters *(h, l)* being auxiliary. Plus *(+)* represents concurrence while arrow *(→)* sequentiality.

There are eleven sequences of pedagogical structure concluded in Table 2. High structured and low structured teaching strategies are equally emphasized in ①④⑤. For ①, low and high structured teaching strategies coexist in the whole teaching process. Such sequence of pedagogical structure can contribute to individualized learning. For ④,the “half class” [20] originating from higher education in China typically belongs to such sequence. For ②⑥⑦⑧, they all emphasize the high structured teaching strategy. ②⑥⑦ are typically traditional sequences of pedagogical structure, while ⑧ is a little different. It starts with a short guide-link phrase which could help motivate students or help them revoke the relevant learnt knowledge before the new lesson. Thus this sequence may be more active than the traditional ones. As to ③⑨⑩⑪, they are all student-centered sequences whose effectiveness has been demonstrated by many solid studies. For a better understanding of these eleven sequences, some possible examples have been given in Table 3.

Table 3. Examples on *friction* in K8 physics subject for the revised SPS framework

SPS	Examples
①L + H	Students design and implement experiment collaboratively to explore the impact factors and measurement of friction, while a teacher gives plenty individualized guidance all the time
②l + H	A teacher delivers a lecture according to the textbook, while students ask questions occasionally
③L + h	Students design and implement experiment collaboratively to explore the impact factors and measurement of friction, while a teacher gives limited individualized guidance
④H → L	Students implement the prescribed experiment collaboratively to test the impact factors of friction in the first half of learning time, and then design and implement a new experiment to explore how to measure friction in the second half
⑤L → H	Students finish the inquiry-based learning on the learning platform in the first half of learning time. A teacher delivers a face-to-face lecture about the proposed questions in the second half
⑥H → H	A teacher delivers a lecture, demonstrates Flash experiment, and lastly asks students to finish structured tests
⑦H → l	A teacher shares a video on friction phenomenon firstly, then delivers a lecture, and lastly leaves a little time for students to reflect and synthesize what they have learnt through concept map
⑧l → H	Students discuss briefly on why it’s easier for people to fall down on ice. Then a teacher delivers new content and demonstrates friction experiment
⑨L → L	Students explore the impact factors and measurement of friction collaboratively through computer models, and write the experiment reports as well as reflective journals
⑩h → L	Students learn a brief video lecture independently, and then design and implement experiment, finishing the exploratory tasks collaboratively
⑪L → h	Students finish an educational game on friction on their own. A teacher gives a brief explanation and conclusion lastly

5 Analysis of Blended Learning Models with SPS Framework

Revised SPS framework (see Table 2) provides a more detailed and in-depth classification of the pedagogical structures of learning activities, which gives a more specific guidance for the blended learning design. In addition, there have already been abundant research achievements about these eleven sequences which can inform the analysis of blended learning models.

5.1 Enlightenment from the Debate on Constructivism

Apart from the information technology, the international debate on constructivism also promotes the popularity of blended learning. This debate began with the published paper: *Why Minimal Guidance during Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-based, Experiential, and Inquiry-based Teaching* [21]. The later relevant arguments all agree that "guidance" is necessary to facilitate better learning, but two further questions are "when to give guidance" and "how much guidance to give" [22]. These questions are actually compatible with the above analysis on "emphasis and temporal orientation" of teaching strategies.

As to "how much guidance to give", according to Kirschner et al. [21], direct, strong instructional guidance is supported by controlled studies rather than constructivist-based minimal guidance, during the instruction of novice to intermediate learners. According to cognitive load theory, Renkl and Atkinson suggested that in the earliest stages of learning, learners should study instructions because intrinsic cognitive load is high; during intermediate stages, they should study worked examples and increase germane load by using self-explanations given schema formation has freed some working memory capacity; in the final stages, there should be sufficient working memory capacity to permit more problem solving. Thus as levels of expertise increase, it is appropriate to decrease instructor control and increase learner control [23]. Another consensus of the debate is that high structured teaching approaches (i.e., direct instruction) is more appropriate for well structured fields of learning, while low structured teaching approaches (i.e., constructivism instruction) is more appropriate for ill structured fields of learning [24]. Therefore, it's necessary to analyze the structure of each pedagogical element to determine the guidance, for example the cognitive structure and development stages of learners, knowledge structure of the subjects and so on.

Regarding "when to give the guidance", Edelson [25] suggested not using mini-lecture or benchmark lesson presenting key information to students until they understand the necessity of that information and its relevance to their problem-solving and investigational practices. Such just-in-time direct lecture was presented as scaffolding for inquiry but not as direct instruction which could promote meaningful learning. Schwartz and Martin [26] also found that ninth graders who initially learned through exploratory problem solving employing statistical principles learned more from a subsequent lecture than students who had initially learned from a worked example that the instructor explained in class. Therefore, the sequences of pedagogical structure from low to high can achieve better learning effect. Recent impressive research findings such as productive failure [27], impasse driven learning [28, 29], and desirable difficulties [30] can all be classified as this kind of sequence.

5.2 Analysis of Typical Blended Learning Models

The current design of blended learning models is still constrained to the narrow definition which takes online learning as the indispensable part. Both the research and practice of blended learning focus on kinds of network technology and relevant resources including online learning platforms such as Moodle and Blackboard, online curriculums such as MOOCs and SPOC, and other online learning environments such as e-Bag, public Wechat platform and virtual society. Horne and Staker [6] analyzed a large amount of blended learning projects and concluded four types of blended learning models according to the combination features of face-to-face learning and online learning. The first is rotation model, meaning rotating between learning modalities according to a fixed schedule or teacher's discretion, which can be further classified into station rotation (rotating in one or more classrooms), lab rotation (rotating to a computer lab for online learning), flipped classroom, and individual rotation (rotating according to individualized learning list). The second is flex model in which online learning is the backbone of student learning aiming to fulfill students' individualized needs by constructing mainly online curriculums or subjects. The third is a la carte model including all the curriculums students need to finish online in the physical campus. The last is enriched virtual model in which students have required face-to-face learning sessions and then are free to complete their remaining coursework online. The rotation model mainly focus on the design at class level while the other three are all designed at the school level. SPS framework can provide an in-depth perspective for the analysis and design of "rotation" at class level.

Take the popular flipped classroom model for example. It liberates the classroom time through moving the direct instruction out of class with support of technology, so as to create a teacher-guided, student-centered, dynamic and interactive learning environment. Flipped classroom developed many different teaching models since it appeared. The flipped classroom model put forward by Robert Talbert is the most well-known which allows students to learn by recorded videos and do auxiliary exercises before class and implements learning activities in class such as evaluation, problem-solving, conclusion and feedback [31]. Video lecture is obviously high structured teaching strategy, while the teacher's guidance and students' explorative collaboration in class can be categorized as "H + L" sequence of pedagogical structure. Therefore, the structure of Talbert's flipped classroom model can overall be characterized as "H → H+L". As to the "exploration-flip-application" model put forward by Ramsey Musallam, and the "experienced participation → concept exploration → meaning construction → demonstration and application" put forward by Jackie Gerstein [31], the structures of them can overall be characterized as "L → H→L". Though these are all called flipped classrooms, different characteristics are shown from the pedagogical structure perspective. Consequently their applicable scope and learning effect must also be different. Talbert's sequence of pedagogical structure is obviously similar with the traditional teaching models, obeying the behaviorism through implementing lecture first and then intensified practice. The only difference is that the proportion of low structured teaching strategy in Talbert's model is larger. On the contrary, Musallam's and Gerstein's models genuinely flip the traditional sequences of pedagogical structure, helping promote deep learning.

6 Conclusion

Many schools are still the products of industry time. How to transform traditional education system to adapt to the new century is an issue that all education researchers and practitioners care about. The development of information technology has brought new hope for education revolution. Blended learning has become an acknowledged development trend. However, just as many revolution hopes ignited by technology development in the history of education, new technology can hardly touch the root of education revolution separately. Such education revolution fads will fade away along with the replacement of technology. Therefore, though blended learning has become a predictable trend of education revolution, it will still be challenging to address the key issues like "to blend or not to blend" and "what extent to blend" if blended learning is still narrowly understood as the combination of face-to-face learning and online learning. Real education revolution must involve pedagogical structure. Structure and function have intimate and dialectical relationship. SPS framework can guide blended learning design, change the role of technology as approaches to support appropriate pedagogical structure and help avoid the overemphasis on technology.

There are at least five categories of ways to optimize "structure". First is through changing the quantity or category of elements; the second is changing the sequence or order of elements; the third is reorganizing all or part of the elements; the forth is changing the weight of elements in the system; the fifth is replacing the old configuration of elements with the new one [32]. Blended learning, integration of information technology and curriculum, education informationization, connectivism and so on all involve some of these optimization approaches. If these theories and practices can be further guided and consolidated from a pedagogical structure perspective, then the burgeoning concepts such as e-Bag, Flipped Classroom, MOOCs and Maker will all not just be fads, but important approaches to change traditional pedagogical structures, so as to establish a brand new education form in the information age.

In the volume of *How people learn: brain, psychology, experience, and school*, the author [33] depicts a diagram including different teaching strategies, and suggests that "asking which teaching technique is best is analogous to asking which tool is best", "in teaching as in carpentry, the selection of tools depends on the task at hand and the materials one is working with". Pedagogical structure plays a decisive role in pedagogical function, in turn, the structure design needs the guidance of function. Pedagogical function arises from specific learning needs. Therefore, the selection and organization of teaching strategies cannot divorce from the analysis of learning needs and learning environment. There is no absolutely best pedagogical structure. Blended learning aims at the relatively best one which can satisfy the external needs and promote optimal learning outcomes.

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Exploring the Relationship Between Social Media, Collaborative Learning and Learners' Satisfaction

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Abstract. Social Media Platforms have become more and more popular and important in daily life. Then, it may be a factor that affecting students' learning satisfaction while it may be an enhancing tool or disturbance. So this study is going to find out whether social media enhance students' learning satisfaction or not by the factors of social media using behavior, purpose of using social media and collaborative learning. The research question was "Would social media enhance students' learning satisfaction?" This study administered a survey questionnaire to 204 university students. Results found that social media behavior ($\beta = .128$, $p < .05$) and academic purpose ($\beta = .667$, $p < .001$) had direct, significant and positive relationship with collaborative learning ($\beta = .763$, $p < .001$) which had a significant and direct positive effect on students' learning satisfaction ($R^2 = .582$). Implications of the factors in predicting satisfaction were discussed.

Keywords: Academic purpose · Collaborative learning · Learning satisfaction · Social media

1 Introduction

Learners' satisfaction can have repercussions on whether learners like to use systems or not, how learners work together and whether there is a good working atmosphere among learners [1]. As the technology is advancing rapidly, students started to use different kinds of social media as a learning tool to communicate and work together. Social media sites that mostly used by Hong Kong students are Facebook, Instagram and Whatsapp. Facebook [2] showed that there were 1.04 billion daily active users on average worldwide on December 2015. Instagram also established that there were more than 400 million active users on the date of September 2015. It is obvious that social media has become part of our daily life and the essential communication implement. Collaborative learning means students learn from sharing resources such as information and tips, and discuss among peers. Group discussion is one of the most effective collaborative learning activities [3]. In summary, it is important to understand whether or not the collaborative learning via social media may enhance students' satisfaction

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towards learning. Therefore, the purpose of using social media has been considered as one of the factors affecting learning satisfaction, as it is how students make use of social media tools. Thus, we set the following research question: What are the factors predicting students' learning satisfaction? The rest of this paper is proposed to be organized as follows. The first section is a review of the research on the collaborative learning on social media and identifies the purpose of using social media that affect students' learning satisfaction. The next section considers genders, age and usage on commonly used social media. The third section develops a model explaining how the factors affecting the satisfaction of learning. The fourth section describes the instrument used to collect the data and its validation. The fifth section reports the model testing result. The final section discusses the aim of the study and considers how social media can enhance learning satisfaction.

2 Literature Review and Hypotheses Development

2.1 Learning Satisfaction

To understand student's learning, not only academic achievement, but also their satisfaction towards learning should be considered. For example, learning satisfaction would not be higher for students who earned better grade in academic performance [4]. Satisfaction is a subjective feeling, but also an important measurement towards learning and teaching process. Student satisfaction with collaborative learning refers to their generally positive feeling towards online activities [5]. Learner interface, learning community, content, and personalization have been suggested as the four factors that measure satisfaction in learning [6]. Moreover, studies found that collaborative is one of the factors that enhancing students learning satisfaction. Previous findings established that majority of students enjoyed collaborative learning and found it fun [7]. To summarize, a number of reasons would affect learning satisfaction and would be discussed below.

2.2 Academic Purpose and Social Media Using Behavior

Social media has become part of our daily life. Meanwhile, using social media to learn and study became one of the purposes among students. Students use social media for not only social purpose, but also educational purpose [8]. Facebook was suggested as an option that worth to proposed online collaborative-working experiences [9]. Moreover, social media could enhance the teaching and learning experience [10]. Students use social media for academic use for mostly citation indexes, document creation, edition and sharing tools, and communication tools. Also, social media were increasingly used for academic purpose (e.g., [11]). On the other hand, students favored the use of Facebook groups for academic purpose because using it to communicate with peers is fast and easy [12]. A prior study tested that the usage of medical students on social media increased when there was a page related to medical knowledge [13]. In short, there should be a link between a clear purpose and the social media use. From these, we argue that the engagement of social media platforms increases when students want to learn. Then, we test,

H1: *The clear the purpose of an individual student in learning, the more the student would use social media*

2.3 Social Media Using Behavior and Collaborative Learning

A lot of people are now using social media. For example, according to Facebook [2], there were over 1.04 billion daily active users on average. People use social media for many different kinds of purposes. When the purpose come to learning, it is possible that students use social media as a collaborative learning tool. A study indicated that social media were being beneficial and useful to the study of students in forms of collaborate and incorporate with others [14]. Also, some findings showed that the engagement of using social media platforms was related to collaborative learning. Collaborative learning and engagement through social media use facilitates the researcher's' intention to use social media as it makes them confident enough to presenting their work [15]. Moreover, the increase of the staff and students use social media is positively related to the use of collaborative learning [16]. From the above, we argue that there is positive relationship among social media use and collaborative learning. Then, we test,

H2: *The more the use of an individual student in social media, the more they would have collaborative learning*

2.4 Academic Purpose and Collaborative Learning

There were many studies found that social media enhanced collaborative learning. For example, some pointed out that the academic purpose of using social media affected positively and significantly with collaborative learning [17] while other argued that students use social media not only for connecting with friends but also for academic purpose like sharing information, cases, and assignments [18]. Another study found that all the respondents were making use of social media platforms in their research and academic works [19]. Since people started to rely on social media to do different kinds of tasks, it has become one of the collaborative learning tools which students can discuss problems, share resources and learn from each other's. Students who use online discussion tool had increased in collaboration frequency than who did not [20]. Moreover, students found social media a useful tool for academic use and would use them to do collaboration. Student's perception regarding social media platforms as being beneficial and useful in their studies that lead them to collaborate and integrate with others through these sites to share resources available to them [14]. Another study revealed that some of the students agreed that social media like Facebook was helpful to their collaborative learning [21]. Overall, we argue that when students use social media for academic use, they increase the use of collaborative learning.

H3: *The clear the purpose of an individual student in learning, the more they would have collaborative learning*

2.5 Collaborative Learning and Learning Satisfaction

Collaborative learning refers to working with a group or a neighbor to achieve shared learning goals (e.g., [22]). Some [23] suggested that the aim of collaborative learning is to ensure students learn through active engagement. Many findings found that collaborative learning is a good method to improve students learning performance and satisfaction. Bloom [24] contended that collaborative test is a valuable teaching strategy that can enhance student learning while other [25] also confirmed that share learning method may increase active engagement of students and enhanced their satisfaction level. Students presented high level of learning satisfaction through collaborative learning [26] where others [27] also proved that collaborative groups produced good quality projects and had positive attitudes toward online collaborative learning. Also, many students found collaborative learning is enjoyable and satisfactory. It was [28] noted that students favored working collaboratively in an online environment though other study [29] illustrated that students were more satisfied working in a group and learn from each other's. From these, we argue that collaborative learning through social media can enhance students' satisfaction of learning. When students engage in collaborative learning, they will receive a higher level of learning satisfaction. Then, we test,

H4: *The more collaborative learning of an individual student, the higher the level of learning satisfaction of that individual student.*

3 Methodology

3.1 Background

In this study, the subjects are all undergraduate students using social media platforms. The study is going to find out the relationship between social media use and learning satisfaction. They were asked to answer a set of questions of their habit of using media and learning satisfaction. The content of the individuals social media platforms open to the followers such as Facebook, Instagram, Whatsapp, YouTube and WeChat. According to Alexa traffic rank, Facebook ranked 2nd, YouTube ranked 3rd and Instagram ranked 24th by measuring page views and number of unique users of the site on January 2016 [30]. The statistic shown that social media is getting popular and widely used nowadays.

3.2 Subjects

This study aimed at understanding undergraduates in their learning, esp. they were heavy social media users and had specific learning purposes. By convenience sampling, this study distributed to 300 undergraduate students at common areas, such as canteen, library at campus of different local universities in Hong Kong. Finally, we received 204 completed questionnaires (67.7 % response rate).

3.3 Measurement Items

The set of questionnaire is adapted from different previously validated scales. In the first part of the questionnaire, the subjects were asked to give their demographic data, including sex, age and the most visited social media. In the second part, to measure Academic Purpose (AP) of using social media, 6-items were adapted [31–34]; to measure Social Media Behavior (SM), 5-items were adapted [35–37]; to measure Collaborative Learning (CL), 6-items were adapted [38]; and to measure Learning Satisfaction (LS), 2-items were adapted [6]. All of them were measuring using 7-points Likert scale ranged from 1 (*strongly disagree*) to 7 (*strongly agree*).

3.4 Data Collection

The questionnaire was distributed to 300 undergraduate students through questionnaire in school campus and students spent about 10 min to complete the questionnaire. The respondents came from different years of study and different local universities.

4 Findings

4.1 Descriptive Statistics of Respondents

There were 203 respondents completed the questionnaire. The details are summarized in Table 1.

Table 1. Descriptive statistics of respondents (N = 204)

Items	Descriptive statistics
Gender	Female: 133 (65.2 %) Male: 71 (34.8 %)
Age (18-27)	*M* (*SD*): 20.77 (1.780)
Most visited Social Media	Facebook: 160 (78.4 %); Instagram: 36 (17.6 %); Others: 8 (4 %)
Average usage per day	*M* (*SD*): 3.16 (2.245)

4.2 Descriptive Analysis of Variables

The descriptive statistics of the measurement items, Social Media Behavior, Academic Purpose, Collaborative Learning, and Learning Satisfaction are shown in Table 2.

Table 2. Descriptive statistics of the variables

	M	*SD*	α	*CR*
Social Media Behavior (SM)				
SM1	5.152	1.362	0.729	0.820
SM2	5.294	1.200		
SM3	4.936	1.380		
SM4	4.490	1.172		
SM5	5.127	1.205		

(*Continued*)

Table 2. (*Continued*)

	M	*SD*	α	*CR*
Academic Purpose (AP)				
AP1	4.966	1.348	0.900	0.923
AP2	4.647	1.626		
AP3	4.338	1.495		
AP4	4.902	1.343		
AP5	4.681	1.449		
AP6	4.667	1.444		
Collaborative Learning (CL)				
CL1	4.7108	1.157	0.916	0.935
CL2	4.564	1.196		
CL3	4.613	1.303		
CL4	4.770	1.166		
CL5	4.686	1.255		
CL6	4.853	1.297		
Learning Satisfaction (LS)				
LS1	4.843	1.218	0.912	0.958
LS2	4.838	1.259		

Table 3. Convergent validity: Factor loadings and AVE

Construct	Factor loadings	Construct	Factor loadings	Construct	Factor loadings	Construct	Factor loadings
SM1	0.707***	AP1	0.858***	CL1	0.802***	LS1	0.960***
SM2	0.659***	AP2	0.838***	CL2	0.876***	LS2	0.957***
SM3	0.621***	AP3	0.856***	CL3	0.878***		
SM4	0.671***	AP4	0.786***	CL4	0.793***		
SM5	0.790***	AP5	0.748***	CL5	0.859***		
		AP6	0.811***	CL6	0.829***		
AVE	0.479		0.668		0.706		0.919

*** $p < .001$

Table 4. Discriminant matrix

	SM	AP	CL	LS
SM	**0.692**			
AP	0.462	**0.817**		
CL	0.436	0.726	**0.840**	
LS	0.363	0.621	0.763	**0.959**

4.3 Reliability and Validity Testing of the Variables

We test the internal consistency by Cronbach's alphas (α), composite reliabilities (CR), and average variances extracted (AVE). Prior studies [39] suggested that, items of a variable are considered as reliable when the values are greater than 0.70 in Cronbach's alphas and composite reliabilities. The construct validity of the instrument was analyzed by using confirmatory factor analysis for both its convergent and discriminant validity. Table 3 indicated that the results of confirmatory factor analysis with factor loadings of each item to its corresponding latent variable were all significant with $p < .001$. The AVE should exceed 0.50 for convergent validity [40]. For the variables above, the variables of Academic Purpose, Collaborative Learning and Learning Satisfaction had met the recommended criteria except Social Media Behavior (see Table 3). However, as all of the variables above met the reliability criteria while Social Media Behavior got 0.479 which was very close to 0.50, which is barely acceptable (see Table 3). Therefore, we still consider the model possessed good internal consistency reliability though we should be careful in dealing with the results. Moreover, the results of the instrument exhibited discriminant validity with each of the diagonal loading greater than both remaining vertical and horizontal loadings (see Table 4). Therefore, all constructs showed both convergent and discriminant validity. This study aimed to find out the relationship of different factors affecting learning satisfaction, which include social media using behavior, academic purpose and collaborative learning. Partial least squares path modeling (PLS) was applied to test the overall model and the paths in the study.

4.4 Hypothesis and Model Testing

For all the models, they were significant ($p < .05$) and the R2 was 0.214, 0.54 and 0.582 for Social Media Behavior, Learning Satisfaction and Collaborative Learning respectively. That means, the models explained 21.4 %, 54 % and 58.2 % of the variance of SM, LS and CL respectively. For H1, it was supported. Academic Purpose had a significant, direct and positive effect on Social Media Behavior, with a standard path coefficient of 0.462 (S.E. 0.064, $p < .001$). This coefficient suggested that every unit of increase in Academic Purpose strengthens Social Media Behavior by 0.462 units. For H2, it was supported. Social Media Behavior had a significant, direct and positive effect on Collaborative Learning, with a standard path coefficient of 0.128 (S.E. 0.059, $p < .05$). This coefficient suggested that every unit of increase in Social Media Behavior strengths Collaborative Learning by 0.128 units. For H3, it was supported. Academic Purpose had a significant, direct and positive effect on Collaborative Learning, with a standard path coefficient of 0.667 (S.E. 0.056, $p < .001$). This coefficient suggested that every unit of increase in Academic Purpose strengthens Collaborative Learning by 0.056 units. For H4, it was supported. Collaborative Learning had significant, direct and positive effect on Learning Satisfaction, with a standard path coefficient of 0.763 (S.E. 0.036, $p < .001$). This coefficient suggested that every unit of increase in Collaborative Learning strengthens Learning Satisfaction by 0.763 units (Fig. 1).

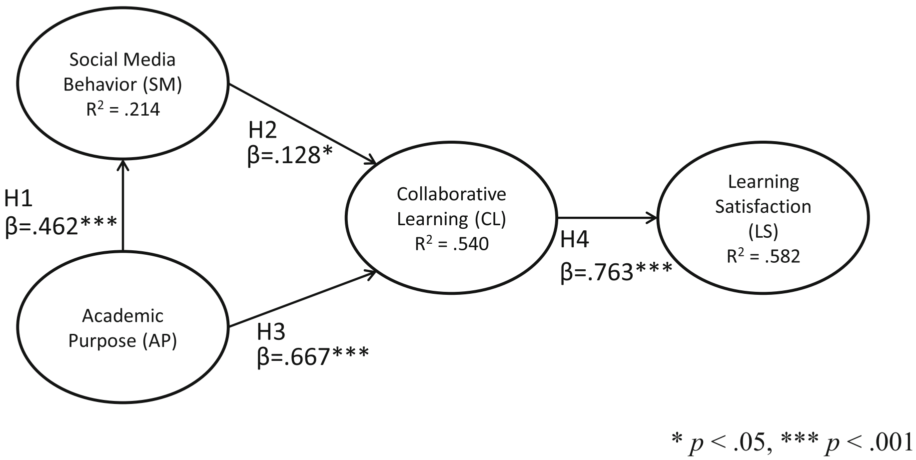

Fig. 1. Model of the relationship between social media and learning satisfaction

5 Discussion

5.1 Academic Purpose and Social Media Using Behavior

Academic purpose has a direct and significant relationship with social media using behavior. The result supports the hypothesis (H1). Social media platforms such as Facebook and Twitter are not only use for social and entertainment use, but also for academic purpose. Academic is one of the most important issues in students' daily life. According to the daily practice of the internet native practice, students usually found social media sites a place to seek for answers, information, exchange ideas and discussion because there are many functions provide them to use as academic or task use tools. So, when it comes to academic purpose site, students engage more such as comment, share and discussion. Thus, students engage more in social media because they use it for academic purpose, which consume most time of students. So, when an individual use the platform that related to their work and study, the individual may invest more time than the one who does not use.

5.2 Social Media Using Behavior and Collaborative Learning

Social media using behavior has a direct and significant relationship with collaborative learning. The result supports the hypothesis (H2). It proved that social media enhance collaborative learning. Collaborative learning required both face-to-face and computer discussion and the study found that students use social media sites, such as Facebook and WhatsApp to do collaborative learning, it may along with the level of common use and popular of social media nowadays. Once more students use social media platform as the tool of collaborative learning, there is an increase in collaboration because the functions of social media sites can form an interaction between users, such as ask question, comments and discussion. For example, Facebook as the most popular social media site, students can use its inbox function to discuss project and homework and share useful and informative posts to peers via wall post. With a higher engagement rate, there is increased in collaborative learning. Also, the functions in those social media sites nowadays are convenient without location limitation. Students may easily find each other's online and share information fast and easily. Moreover, the result of the study is coincided with the finding of Tomsic and Suthers [20] who proposed that students who using online discussion tool had increased in collaboration frequency than who did not.

5.3 Academic Purpose and Collaborative Learning

Academic purpose has a direct and significant relationship with collaborative learning. The result supports the hypothesis (H3). The study found that students use social media for academic purpose such as coordinate activities for projects, schedule meeting or appointment and seek task information from the peers. These activities of academic purpose benefit collaborative learning. Once students consider social media as an effective tool for academic, they will do more online collaborative learning, such as provide information online, give and receive feedback through social media instead of other tools or even face-to-face communication. Therefore, when more students use social media for academic purpose, the more collaborative learning occurs.

5.4 Collaborative Learning and Learning Satisfaction

From the study, we found that collaborative learning has a direct and significant relationship with learning satisfaction. The result supports the hypothesis (H4). It demonstrated that collaborative learning could increase the level of satisfaction. Collaborative learning is one of the most common learning methods in high-education. It means that two or more students learn or attempt to learn some knowledge together while students may ask information, evaluating the ideas and monitoring work from their members. This study proved that collaborative learning could enhance the level of satisfaction of students, in line with the findings of prior studies (e.g., [41]). On the other hand, learning satisfaction will be influenced by the quality, including usefulness and effectiveness, of the computer system [42]. The major causes are due to free, comfortable and willing to ask questions, share ideas and express own opinions through social media with the peers as most of the students in Hong Kong are hesitate and shy to express their notions.

5.5 Limitation and Further Studies

There were several limitations in this study. The study didn't measure individual characteristics of the learners, for example, cognitive learning style [43] where previous studies found relationships with collaborative learning [44]. Moreover, it would have better if the questionnaire had been conducted in Chinese, as the mother tongue of students in Hong Kong is mainly Chinese. Last but not the least, the sample size could be larger and conduct in more high-education schools in order to cover more respondents.

6 Conclusion

All in all, the study found that social media is a useful and effective tool that enhancing collaborative learning. Students are willing to use social media sites not social and entertainment use, but also academic and task use. It is no doubt that student willing to use social media sites to do collaborative learning. After all, it also enhances the level of students learning satisfaction that they feel happy and fulfill on study via social media to do collaborative learning.

Appendix A. Measurement Items Used in the Study

Construct	Measurement Items
Social Media Behavior	
SM1	Checked out people's walls without leaving a message
SM2	Checked out people's photos without leaving comments
SM3	Facebook Chatted with others
SM4	Replied to others' comments on your profile photo, new photos, fan status, "what's on your mind" status, group status, notes, and links
SM5	Checked out people's notes, links, and various status without leaving comments
Academic Purpose	
AP1	Coordinate activities for projects.
AP2	Schedule meeting/appointments.
AP3	Monitor progress of projects.
AP4	Distribute/provide information.
AP5	Seek task information from people I know.
AP6	Give and receive feedback on reports and ideas.
Collaborative Learning	
CL1	Allows all members to benefit from the contributions published by your peers
CL2	Encourages that other students help solving questions and difficulties of their peers
CL3	Fosters the spreading of your own ideas and points of view and influence point of view of others
CL4	Helps you to learn from and consider other students´ points of view about problems and cases
CL5	Allows the coordination of joint actions with peers for other activities outside the course (e.g. prepare assignments for other subjects)
CL6	Social media provides helpful tools to facilitate team working

(*Continued*)

(*Continued*)

Construct	Measurement Items
Learning Satisfaction	
LS1	As a whole, you are satisfied with using social media as a project and academic discussion tool.
LS2	As a whole, using social media as a project and academic discussion tool is successful.

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Improvement Strategies of Pupils' Self-Efficacy in Smart Learning Environment – A Case Study

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Abstract. With the development of smart education, self-efficacy is becoming more important to pupils' learning performance. This study develops a scale in measuring self-efficacy of pupils in a smart learning environment based on the connotation and structure of self-efficacy as well as learning behaviors of pupils in a smart learning environment. The survey, carried out in several primary schools in the Pearl River Delta (PRD) region of China, suggests that the self-efficacy of pupils in a smart learning environment is at a level of medium or above. However, specific items such as environmental adaptation, sense of self-control, awareness of collaborative study and belief on producing works are relatively poor. This study then proposes corresponding improvement strategies of self-efficacy including creating learning contexts, monitoring learning process, promoting interaction and encouraging personalized creation, based on functions of a smart learning environment.

Keywords: Self-efficacy · Smart learning environment · Improvement strategies of self-efficacy · Pearl River Delta region

1 Introduction

Self-efficacy was the belief or behavior in one's capabilities to accomplish a task, and a form of self-evaluation about one's achievement. Within social cognitive theory of Bandura, self-efficacy was the nearest cognitive variable from people's motivation, emotion and action, as well as an important intervening variable that conveyed the impact of environmental changes to human behavior [1]. As one of the most important determinants of e-learning, self-efficacy has a close relationship with academic anxiety, motivation, goal setting and self-monitoring of learners, and would have impacts on the final learning outcomes [2]. Thus, self-efficacy is significant in the improvement of student's learning performance [3]. A smart learning environment is a learning and activity space that could perceive and sense learning scenarios, analyze characteristics of learners intelligently, provide proper learning resources and interactive tools, capture

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data during a learning process automatically and evaluate learning outcomes to support effective learning [4]. The White Paper on Chinese Smart Learning Environment 2015, published by Smart Education Institute of Beijing Normal University, indicated that a smart learning environment would be the basic support for studying in information age, meeting digital natives' demands of learning anytime, anywhere, anyway and at any pace. Smart learning environment in this paper is defined as a learning environment combining various intelligent technologies, consisting of various types of learning devices such as tablet computer and e-schoolbag, and a cloud platform. There is no doubt that smart learning environment, unlike traditional learning environment, raises new requirements for pupils' competency in information literacy and network capability, which become essential elements to research on pupils' self-efficacy in smart learning environment.

Early research on self-efficacy focused on the factors, development of a scale in questionnaires, relationship to other variables such as grades and improving strategies. Starting from Bandura's Triadic Theory of Learning, Bian divided self-efficacy into four dimensions, including *sense of environment, ability, endeavor and control* [5]. Xie *et al.* further explained the meaning of these four dimensions and developed an improved scale [6]. They explained that *sense of environment* refers to individual's feeling such as adaptation and familiarity about an environment; *sense of ability* refers to individual's belief on their abilities required in e-learning; *sense of endeavor* refers to individual's belief on their willingness to make an effort; *sense of control* refers to individual's belief on self-control about e-learning activities and learning behaviors. Besides, the research team carried out an empirical research on the improvement of students' self-efficacy with the Personal Learning Space [7, 8] and verified its effect [9]. There are few studies on pupils' self-efficacy about the development of scales and relationship to other variables. For instance, Chen and Guo developed the E-learning Self-efficacy for Middle and Primary School Students [10]. Liu *et al*. found that pupils' self-efficacy had a positive influence on their acceptance of e-book [11].

In summary, early studies on self-efficacy in networked environment focused exclusively on college students and adult learners. It is thus important to investigate the status quo, problems and the correspondingly improvement strategies of pupils' self-efficacy in a smart learning environment.

2 Research Design

Along with the construction of smart city clusters, the development and applications of smart learning environments are in a leading position in the Pearl River Delta (PRD) region of China where advanced technologies such as Internet of Things (IOT), big data and cloud computing are widely used in education. Such development of smart learning environment in the PRD region provides a good basis and platform for our research.

In this study, we attempted to find out the connotation and structure of self-efficacy of primary pupils in e-learning and develop a draft Scale for Pupils' Self-Efficacy in Smart Learning Environment. This draft was modified through the Factor Analysis after carrying out a pre-test for 147 pupils from two primary schools in the PRD region.

Then, 192 primary pupils from three schools in that region were chosen to take the final-test to investigate the status quo and problems of pupils' self-efficacy in smart learning environment, with their basic information shown in Table 1. We then proposed several improving strategies as a result. The specific research design is shown in Fig. 1.

Table 1. Basic information of samples in final-test

Gender		Grade		District			Parents highest degree		
Male	Female	Four	Five	Urban	Suburban	Rural	Doctor	Master	Bachelor
94	91	96	89	108	57	20	37	133	15

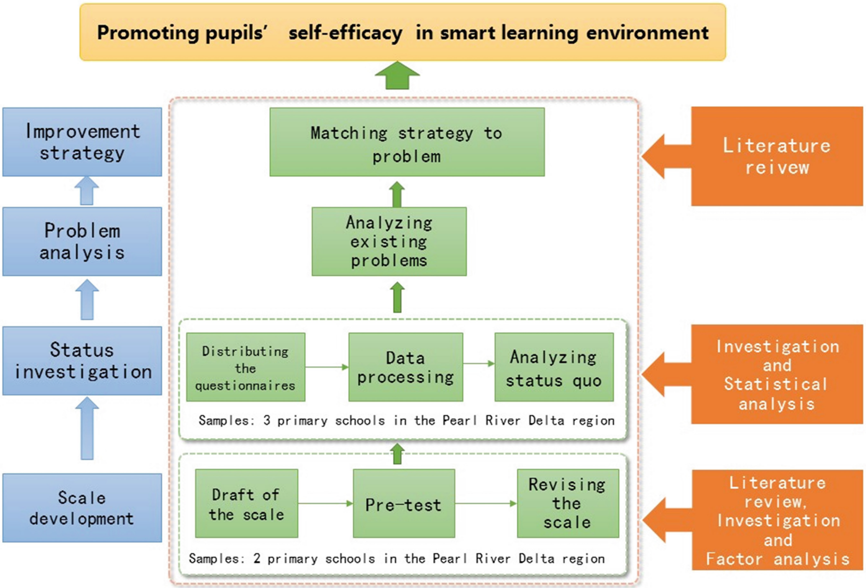

Fig. 1. Research design

3 Scale Development

3.1 Rationale

Bandura [1] emphasized the analysis of all related concepts of a selected field and absorbed anything in education relevant to self-efficacy in order to build a reasonably comprehensive scale in self-efficacy in learning. There are questions about from which perspective a learning self-efficacy framework to be constructed. Chen and Guo [10] developed a questionnaire for Elementary and Secondary School Students' Self-Efficacy in which three important factors including Internet fulfillment, ability of using Internet and learning expectation on Internet. Based on the General Self-Efficacy Scale of Schwarzwe, a famous German psychologist, Peng *et al.* [12] developed the Self-Efficacy Scale for Distance Learning consisting of three major dimensions: general self-efficacy, skill-based self-efficacy such as operating computers, and learning process-oriented self-efficacy.

Taking the characteristics of primary students in mind, we suggest four dimensions of self-efficacy of pupils in a smart learning environment in this paper including *sense* of *environment, ability, endeavor* and *control*.

E-learning behaviors are learning behaviors in an e-learning environment, which can be observable and measurable behaviors like reading and practicing, or implicit activities like memorizing and analysis [13]. Xie *et al.* [8] generalized all e-learning behaviors as information behaviors such as learning behaviors through searching, browsing, processing, publishing and exchanging ideas according to the general process of learning. Song and Zhou [14] divided e-learning capacities into abilities of computer operation, communication, emotional management, time management, and knowledge management.

Our scale will look into behaviors and abilities of using smart devices in a networked platform, including the abilities and behaviors of information acquisition collaborative communication, work formation and critical evaluation, which involve the ability of learning independently and cooperatively.

3.2 The Draft of the Scale

We developed a draft Scale of Self-Efficacy in Smart Learning Environment by analyzing pupils' learning behaviors and abilities in a smart learning environment. Split up into four dimensions, the first draft consists of 18 items concerning pupils' adaptation to a smart learning environment, belief on using smart devices, and their self-evaluation about learning attitudes and level of efforts. The structure of the draft is shown in Fig. 2.

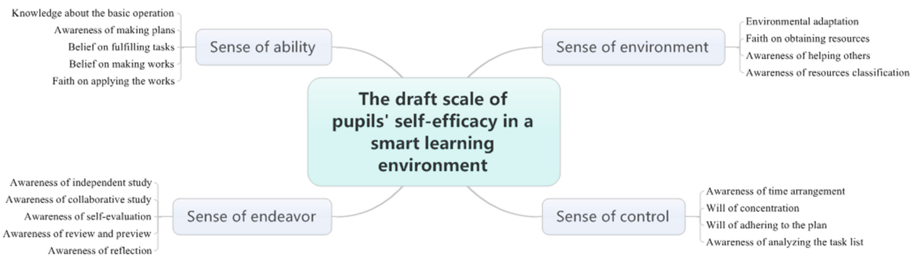

Fig. 2. The draft scale of pupils' self-efficacy in smart learning environment

3.3 Pre-test

147 students from two classes of Grade 4 and one class of Grade 5 of two primary schools in the Pearl River Delta region were chosen as samples of pre-test, with 141 valid returned, which were used for the revision of the scale.

3.4 Revision of Scale

14 items of the draft of the scale were maintained after the exploratory elements analysis by SPSS, which was analyzed by confirmatory factor analysis through AMOS. Table 2 shows the hypotheses of the model.

Table 2. Fit indices of the scale

RM-SEA	GFI	NFI	CFI	IFI
0.078	0.932	0.924	0.927	0.933

It is generally acknowledged that the measurement fitting degree will be good when RE-SEA is under 0.08 (the lesser the better), and GFI, NFI, CFI and IFI are over 0.9 (the more the better). The value of x^2/df, which is used to test sample covariance matrix and estimate the degree of similarity between covariance matrix, was 1.76, indicating the scale possessed high structural validity. The value of Cronbach's alpha of four-dimensional subscales ranged from 0.626 to 0.863, and the reliability of the whole scale is 0.933 > 0.9, indicating a reliable scale. The scale is a five-point Likert scale with 70 total points, the value of each item ranging from 1 to 5, the structure of which is shown in Fig. 3.

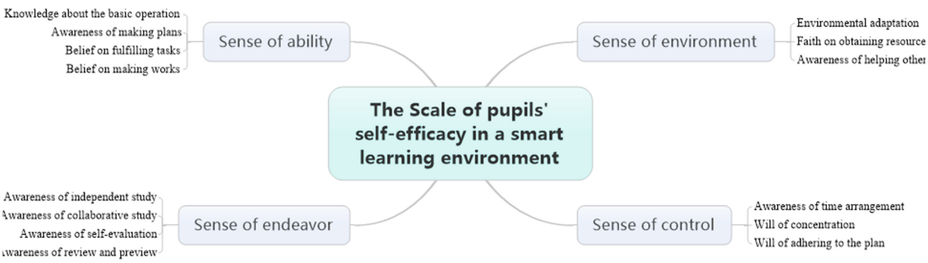

Fig. 3. The scale of pupils' self-efficacy in a smart learning environment

4 Data Analysis

4.1 Status Analysis

192 pupils of three schools in the Pearl River Delta of China were selected as our testing objects that helped our investigation by filling the revised questionnaire with 185 valid returned questionnaires. This survey aims to investigate pupils' self-efficacy in the smart learning environment and to review existing problems.

4.1.1 The Overall Level

The results of the survey show that the whole score ranges from 14 to 70. As shown in Fig. 4, with an average of 46.5 and median of 43, the value of most pupils' self-efficacy is above average (Axis of symmetry) and thus at the upper-middle level.

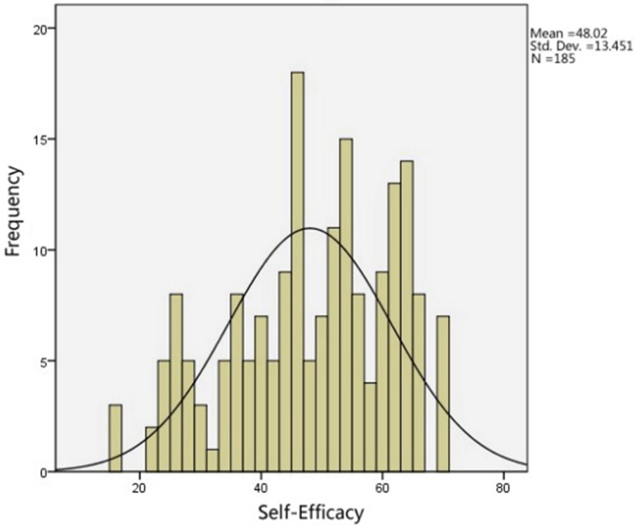

Fig. 4. Histogram of the sample

4.1.2 The Status of Each Dimension

In order to understand the status of pupils' self-efficacy in a smart learning environment, each dimension of self-efficacy is discussed and descriptive statistics of each dimension are shown in Table 3.

Table 3. Descriptive statistics

	N	Range	Minimum	Maximum	Mean	Std. deviation
Sense of environment	185	12	2	5	3.84	2.470
Sense of control	185	12	1	4	2.92	2.729
Sense of endeavor	185	16	1	4	3.30	3.507
Sense of ability	185	14	2	5	3.68	3.050

As indicated in Table 3, scores of *sense of environment* and *sense of ability* are higher than the others, with an average score 3.84 as well as 3.68, while *sense of endeavor* and *sense of control* are lower than the theoretical median level. That is to say, primary pupils can perceive and learn in a smart learning environment, while their ability to control the learning process and their belief on endeavor degree are in slight deficiency. We further analyzed specific circumstances of the four dimensions with results shown in Table 4.

4.1.2.1 The Analysis of *Sense of Environment* Dimension

The score of *awareness of helping others* is higher than other items indicating that pupils are willing to help others solve problems in a smart learning environment. But the score of *environmental adaptation* is low, suggesting that pupils do not adapt to the smart learning environment, which may be related to the environmental characteristics, the time of entering the environment and students' adaptability, etc.

Table 4. The scores of Sense of environment dimension

Primary index	Secondary indexes	The mean score of each item	The total mean score
Sense of environment	*Environmental adaptation*	3.56	3.84
	Faith on obtaining resources	3.66	
	Awareness of helping others	4.30	

4.1.2.2 The Analysis of *Sense of Control* Dimension

The result shown in Table 5 indicates that the score of *Sense of control* is the lowest, which may be resulted from pupils' control consciousness, study habits and other factors. The mean scores of *awareness of time arrangement* and *will of concentration* are below the theoretical value, indicating that their attention needs further guidance in the smart learning environment.

Table 5. The scores of Sense of control dimension

Primary index	Secondary indexes	The mean score of each item	The total mean score
Sense of control	*Awareness of time arrangement*	2.95	2.92
	Will of concentration	2.74	
	Will of adhering to the learning plan	3.07	

4.1.2.3 The Analysis of *Sense of Endeavor* Dimension

Data in Table 6 shows that *awareness of independent study* is high, so we can assume that the smart learning environment may enhance pupils' awareness of autonomous learning through the provision of relatively convenient functions. But *awareness of collaborative study* is low, which may relate to their strong self-centeredness.

Table 6. The scores of Sense of endeavor dimension

Primary index	Secondary indexes	The mean score of each item	The total mean score
Sense of endeavor	*Awareness of independent study*	3.51	3.30
	Awareness of collaborative study	3.06	
	Awareness of self-evaluation	3.21	
	Awareness of preview and review	3.42	

4.1.2.4 The Analysis of *Sense of Ability* Dimension

The score of *understanding of the basic operation* is the highest indicating that pupils can learn with smart devices in the smart learning environment skillfully (Table 7). While the score of *belief on producing works* is minimal, stating that primary students' belief of composing works require promotion through utilizing the smart learning environment.

Table 7. The scores of Sense of ability dimension

Primary index	Secondary indexes	The mean score of each item	The total mean score
Sense of ability	*Understanding of the basic operation*	4.32	3.68
	Awareness of making plans	3.64	
	Confidence in completing exercises	3.52	
	Belief on producing works	3.24	

In summary, the survey data shows that pupils' self-efficacy in the smart learning environment is at the upper level with *Sense of environment* and *Sense of ability* relatively higher, but *Sense of endeavor* and *Sense of control* less satisfactory.

4.2 Problem Analysis

Through analyzing data in each dimension of self-efficacy and interviewing students, there are four problems identified on pupils' self-efficacy in the smart learning environment.

4.2.1 Weak Environmental Adaptation

The problem of maladjustment to the smart learning environment will reduce enthusiasm of pupils leading to the decrease of self-efficacy, which in turn would affect students' learning performance. At the same time, teachers also take times to adapt to this new environment so effective guidance may not be given to pupils in a timely manner, resulting in poor adaptation as a whole.

4.2.2 Lack of Self-Control

Self-control of primary pupils is generally weak, of which *awareness of time arrangement* and *will of concentration* are the weakest. Therefore, it is necessary to promote abilities of time arrangement and will of concentration via functions of monitoring and management on the smart learning environment, so as to enhance students' sense of control, and ultimately to build self-confidence in learning.

4.2.3 Insufficient Cooperative Consciousness

Although pupils have improved their awareness of developing independent learning, self-evaluation, previewing and reviewing on time in the smart learning environment but still hesitate in launching collaborative learning activities with others. Despite of plenty of communication tools available for collaborative learning in a smart learning environment for primary pupils, enhancing the awareness of cooperative learning among pupils is still of important concern.

4.2.4 Lack of Confidence in Creativity

When pupils have knowledge of a smart learning environment and could take suitable tools to work on exercises, quizzes and games, what hinders them from carrying out the creative activities as expected is the belief that they can finish their work creatively with existing tools.

5 Improvement Strategies

Bandura [15] believed that the development of self-efficacy might come from prior achievements, vicarious experiences, persuasion, affective reaction and physiological states of a person in activities. Therefore, we can improve pupils' self-efficacy by providing more successful experiences and vicarious experiences, emotional encouragement, and adjustment of affective and physiological states in learning.

Many functions in a smart learning environment can be used to promote self-efficacy. Perceiving and sensing learning scenarios may help creating various learning context to augmented reality. Personalized learning resources can be pushed based on a student model. Automatic data capture in learning processes with intelligent analysis and diagnoses may provide meaningful instant feedback. Intelligent evaluation on student works may enhance the beliefs of managing and controlling their own learning. The learning community provides students with social and emotional support to improve their belief in collaborative learning and to facilitate interactions among learners. The improvement strategies of self-efficacy supported by functions of a smart learning environment are to be discussed in this section and summarized in Fig. 5.

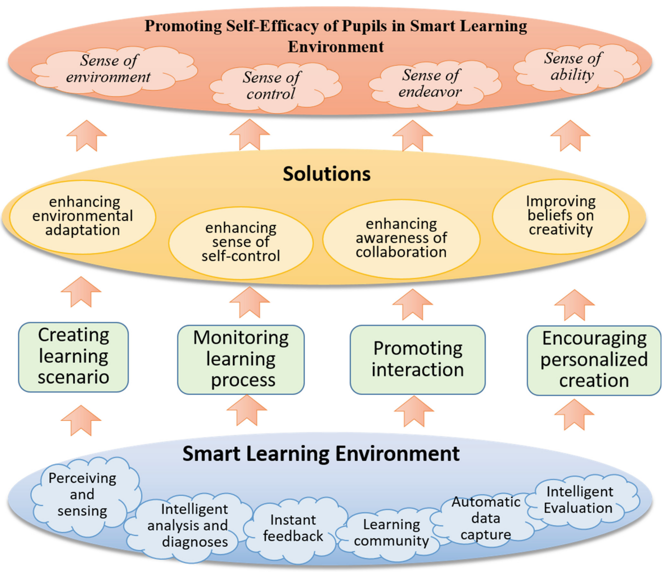

Fig. 5. improvement strategies of pupils' self-efficacy in a smart learning environment

5.1 Creating Learning Scenarios to Enhance Environmental Adaptation

Bandura [15] believed that information from different environments is not the same. When a person encounters a strange situation, the level of self-efficacy will be reduced. Smart learning environment can perceive and sense learning content in a variety of learning scenarios to enable augmented learning experience on different scenes. Smart learning environment can push learning resources based on a learner's learning style and personal need, which aim to reduce their anxiety, stimulate learning motivation, learning interest and thus facilitate environmental adaptation.

5.2 Monitoring Learning Process to Strengthen the Sense of Self-Control

Being poor in *self-control* and the lack of will in concentration are the main reasons for the low level of *Sense of control*. Stimulating students' learning interests and with better learning process management by a smart learning environment may help in this respect. For example, micro videos and multimedia contents may be more appealing to pupils and help maintaining concentration; and arranging learning units in a right level of difficulty with reducing number of units in e-schoolbag may help reducing their cognitive loads. A smart learning environment can also monitor the learning process with automatic data capturing from learning activities, which contributes to their self-planning, self-monitoring, self-evaluation and enhance students' sense of control.

5.3 Promoting Interaction to Enhance Awareness of Collaboration

Bandura highlighted that vicarious experiences plays an important role in cultivating individual self-efficacy. Functions such as instant communication and online collaboration can help teachers organize collaborative learning activities and provide affective support to students. When pupils see successful cases from those with similar abilities and personality, their self-efficacy may be effectively stimulated.

5.4 Encouraging Personalized Creation to Improve the Beliefs on Creativity

There are a variety of tools in a smart learning environment to support working and sharing. For example, it is possible for students, with the use of mobile devices, to draw mind maps, paint, take a picture, and make a movie individually or collaboratively. Works could then be shared via the e-schoolbag platform, on which teachers, students and parents can discuss and appraise together.

Apps in smart learning environment can support edutainment learning style, simplifying the creation process and encouraging personalized creation. Therefore, pupils may gain the sense of accomplishment they need to improve their self-efficacy.

6 Conclusion

We investigated the status of the self-efficacy of primary school students in a smart learning environment with several representative schools in the Pearl River Delta region of China, going through the process from scale development, status investigation, problems analysis to suggesting improvement strategies. The research results are summarized as follows.

(a) Based on the characteristics of primary school students, the scale of pupils' self-efficacy in a smart learning environment was developed with four dimensions in the sense of *environment, control, endeavor* and *ability*.
(b) The status quo and problems of pupils' self-efficacy in smart learning environment in the Pearl River Delta region were investigated using the scale. We found that the self-efficacy of pupils in a smart learning environment was above average and the *sense of environment and ability* were relatively high.
(c) There are some problems of self-efficacy in a smart learning environment for pupils in the Pearl River Delta region; especially in the areas of *environmental adaptation*, *sense of self-control*, *sense of cooperation* and *confidence in creation*.
(d) We suggest improvement strategies in addressing these problems with supports from functions in a smart learning environment, including creating various learning scenarios, monitoring learning processes, promoting interaction and encouraging personalized creation.

This study provides valuable experience in improving self-efficacy of pupils in a smart learning environment.

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Investigating Factors Influencing K-12 Teachers' Intention to Integrate Mobile Devices in Teaching

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Abstract. The purpose of this study was to explore the key factors influencing K-12 teachers' intention of mobile devices integration in teaching. A structural model of the factors influencing teachers' intention to integrate mobile devices in teaching was proposed based on an extensive literature review. Based on the proposed model, a survey was administered which included six categories: (1) Attitude and technology belief; (2) Mobile-based pedagogical knowledge; (3) Mobile device skills; (4) Institutional support; (5) Self-efficacy of mobile-based teaching; and (6) Intention to integrate mobile devices. Partial Least Squares (PLS) were employed to validate the proposed model and hypotheses, using the data collected from 22 primary school teachers via surveys. The results indicated that teachers' attitude and technology belief, and self-efficacy of mobile-based teaching had significant impacts on their intention to integrate mobile devices in teaching. Meanwhile, teachers' mobile device skills strongly influenced their self-efficacy of mobile-based teaching. Finally, the authors provided suggestions for teachers, school leaders, and researchers.

Keywords: Mobile devices · Integration · Influencing factors · K-12 teachers

1 Introduction

Mobile devices, such as laptops, personal digital assistants (PDAs), tablet computers, and e-book readers, have been popular worldwide in educational settings, especially in K-12 classrooms [1]. The large amount of computing power and increased affordability and functionality, combined with the wireless communication, makes mobile devices a learning tool of great potential in both traditional classrooms and outdoor informal learning [2, 3]. Numerous researchers have come to agreement that mobile devices could

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provide new ways to learn [4], increase learning engagement [5], foment autonomous learning [6], facilitate access to information [7] and promote collaborative learning [8].

However, despite the widely acknowledged potential of mobile devices on learning [9], the integration of mobile devices in K-12 teaching has been far from satisfactory. DiVall [10] reported that in a department-wide iPad pilot program, 61 % of faculty members used iPads in seminars/laboratories, 57 % used iPads in the experiential setting, and only 43 % used iPads in the classroom.

Storz [11] identified the challenges of mobile technology integration with education as: emphasizing the presence of mobile devices, but ignoring the infusion of mobile devices into curriculum and teachers' instructional experiences. Additionally, November [12] stated the availability of mobile devices does not correlate to the integration of mobile technology in education, as integration depends on teachers' personal beliefs and experiences.

Previous research has shown that teachers are the most important element in integrating technology in the classroom [13, 14]. Specifically, teachers' adoption of mobile devices in teaching is directly related to and determined by the impact of mobile devices on classroom environment. However, it should be noted that, mobile devices are not designed as educational tools, and therefore, teachers' adoption of mobile devices in teaching is likely to present challenges [15]. Furthermore, few studies have attempted to understand what affects teachers' willingness and intention to integrate mobile devices in teaching.

This study aimed to determine the key factors influencing K-12 teachers' integration of mobile devices in teaching through employing the structural modeling technique.

2 Related Works

This section reviews the theoretical and empirical literature related to technology integration, including the barriers of ICT integration with K-12 education and other influential factors of ICT integration with education.

2.1 Barriers of ICT Integration with K-12 Education

Ertmer [16] proposed that two levels of barriers exist when integrating technology in classrooms. First-order barriers are external, such as, lack of adequate access, time, and training. Second-order barriers are internal to teachers' personal belief systems, including pedagogy, technology, and willingness to change. Furthermore, Ertmer [17] claimed that no one barrier is most significant, and rather, the magnitude of challenges presented by each type of barrier varies depending on the situation. Some researchers have empirically identified first-order barriers and second-order barriers as predictors of teachers' intention to use ICT in teaching. For example, with regard to first-order barriers, Nikolopoulou and Gialamas [18] proved that lacking of devices and technical support were key barriers that hindered ICT integration in teaching. Lim and Pannen [19] also suggested that lacking of funding investment and personnel support significantly influenced teachers' technology integration. Dionys [20] found that digital instructional resources and ICT infrastructure were also influencing factors of ICT integration with education. Furthermore, a variety of studies have identified teachers' beliefs as a predictor of their intention to use ICT [21, 22].

In addition, Tsai and Chai [23] argued that the lack of design thinking by teachers may be the "third"-order barrier for technology integration. These authors described design thinking as a process for improving current situations and creating what is desired, and therefore concluded, design thinking may provide solutions to both first and second-order barriers as it addresses all problems that need to be resolved through human creativity [23].

2.2 Other Influencing Factors of ICT Integration with Education

Apart from the above barriers, the following factors may also influence ICT integration with education.

2.2.1 Demographic Factors

Lin [24] argued that teachers' age influences confidence in ICT integration, and their intention to integrate ICT in class was affected by gender. However, Alazam et al. [25] found that teachers' demographic factors (e.g., age, gender, teaching experience, educational background) did not influence ICT integration in the classroom. Similarly, other researchers have also reported that gender was not an influencing factor with regard to ICT integration [26, 27].

2.2.2 Knowledge and Skills

A variety of studies have concluded that knowledge and skills surrounding ICT pedagogy and classroom management are the major factor influencing technology integration. Chen [28] found that a deficit in ICT skills significantly affected pre-service teachers' ICT integration in education. Additionally, Angeli [29] suggested that teachers' TPACK determined the effects of ICT integration.

2.2.3 Institutional Support

Vanderlinde [30] found that school-based ICT policy was a key factor that influenced the quality of ICT integration in classrooms. Tay [31] suggested that school leadership played supporting functions in the process of integrating ICT into the teaching and learning process. Perrotta [32] reported that supportive leadership influenced teachers' actual use of ICT in class and Karaca [33] stated that principal and colleague support played important roles in technology integration in elementary school.

2.2.4 ICT Self-Efficacy

According to Liaw, Huang and Chen [34], teachers' computer self-efficacy has significant impact on their use of ICT in teaching. Similarly, Callum, Jeffrey, and Kinshuk [35] concluded that teachers' self-efficacy to effectively use ICT in teaching significantly affected their adoption of new technology in teaching. Furthermore, Gan and Balakrishnan [36] reported that technology self-efficacy was an adoption factor of mobile wireless technology for teachers.

2.2.5 Subject Culture

Goodson [37] suggested the existence of culture clash in using ICT. Researchers suggested some ICT tools were only applicable to specific subjects, for example, graphic tools used in mathematics [38], visual tools used in science [39], and language tools used in English [40]. Additionally, Hennessy [38] argued that teachers are reluctant to adopt a technology which seems compatible with the norms of an antecedent subculture. For example, Selwyn [41] reported that art teachers believed using a mouse makes one's mind and hand disjointed. Recently, Howard [42] proved that in conjunction with other important factors, subject area is an important part of teachers' technology integration.

3 Structural Model and Hypotheses for Factors Influencing Teachers' Mobile Devices Integration in Teaching

Since mobile devices are an advanced ICT, the factors influencing ICT integration, in a general extent, may also be applicable to mobile device integration. Therefore, based on the factors influencing ICT integration, the authors proposed Fig. 1, which is a structural model for several factors influencing teachers' mobile device integration.

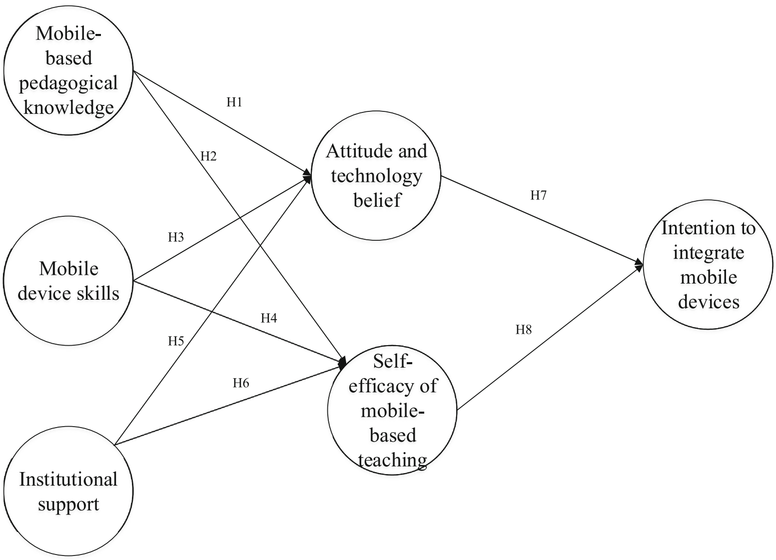

Fig. 1. Structural model for factors influencing teachers' mobile device integration

The structural model consists of six variables, including teachers' attitude and technology belief, mobile-based pedagogical knowledge, mobile device skills, institutional support, self-efficacy of mobile-based teaching, and intention to integrate mobile devices. The arrows specify the hypothesized relationships among these variables, and the following are eight hypotheses of the structural model:

H1: Mobile-based pedagogical knowledge has a positive association with attitude and technology belief.
H2: Mobile-based pedagogical knowledge is positively related to self-efficacy of mobile-based teaching.
H3: Mobile device skills has positive association with attitude and technology belief.
H4: Mobile device skills is positively related to self-efficacy of mobile-based teaching.
H5: Institutional support has a positive association with attitude and technology belief.
H6: Institutional support is positively related to self-efficacy of mobile-based teaching.
H7: Attitude and technology belief has a positive association with intention to integrate mobile devices.
H8: Self-efficacy of mobile-based teaching is positively related to intention to integrate mobile devices.

4 Method

4.1 Participants

The participants of this study were teachers from a primary school located in central China. This primary school was chosen because it has "smart classrooms" with student capacities of 50 and a 1:1 student to tablet computer ratio. Furthermore, the school employs teachers which have experienced teaching with mobile devices for about two years. Table 1 shows demographic information of the participants.

Table 1. Demographic information of the participants

Demographic information		Number
Gender	Male	5
	Female	17
Age	< 30	17
	31–40	5
Years of teaching	< 2 years	1
	3–5 years	11
	6-10 years	7
	11–15 years	2
	> 15 years	1
Educational background	Bachelor	14
	Master	8

4.2 Instrumentation

In order to investigate the key factors that influenced teachers' mobile device integration, a survey was developed based on the proposed structural model for factors influencing teachers' mobile device integration. The survey was validated by three technology integration experts prior to distribution. The survey contained demographic items, such as gender, age, years of teaching, and educational background, and the six categories of the proposed structural model.

All items were presented in a five-point Likert scale (i.e., strongly agree, agree, neutral, disagree, and strongly disagree). A response of 'strongly agree' was assigned to 5, while 'strongly disagree' was assigned to 1.

4.3 Data Collection

Twenty-five teachers were invited to complete the survey, and a total of 22 complete responses were collected, including 5 male teachers and 17 female teachers.

5 Results

5.1 Reliability and Validity of the Survey

Through structural equation modeling analysis, this study confirmed the validity and reliability of each category in the survey. The results of the validity and reliability of the survey are shown in Table 2. The column of Average Variance Extracted (AVE) show coefficients of each category were over 0.55, which was satisfactory. Moreover, it was found that all composite reliability (CR) coefficients were over 0.8,

Table 2. Reliability and validity of the survey

Category	Item	Factor loading	AVE	CR
Attitude and technology belief (ATB)	ATB 1	0.75	0.67	0.86
	ATB 2	0.79		
	ATB 3	0.91		
Mobile-based pedagogical knowledge (MPK)	MPK 1	0.96	0.84	0.94
	MPK 2	0.88		
	MPK 3	0.91		
Mobile device skills (MDS)	MDS 1	0.90	0.84	0.91
	MDS 2	0.93		
Institutional support (IS)	IS 1	0.95	0.59	0.80
	IS 2	0.57		
	IS 3	0.73		
Self-efficacy of mobile-based teaching (SMT)	SMT 1	0.75	0.62	0.87
	SMT 2	0.77		
	SMT 3	0.82		
	SMT 4	0.80		
Intention to integrate mobile devices (IMD)	IMD 1	0.68	0.59	0.81
	IMD 2	0.75		
	IMD 3	0.86		

which also demonstrated satisfactory reliability of the survey. The reliability of each item was assessed by its factor loading onto the underlying construct, which were all over 0.55 and within acceptable limits. Accordingly, the survey employed in this study is a valid and reliable instrument for investigating factors influencing teachers' mobile device integration in classrooms.

5.2 Teachers' Responses on the Survey

As indicated in Table 3, teachers' scores in the six categories were low. The findings revealed that teachers lacked skills and self-efficacy when using mobile devices in teaching, and teachers' perceived institutional support was low. Additionally, teachers' attitude and technology belief was not very positive and their intention to integrate mobile devices in teaching was not strong.

Table 3. Descriptive analysis of teachers' responses

Category	Mean	SD
Attitude and technology belief	3.80	.25
Mobile-based pedagogical knowledge	3.74	.32
Mobile device skills	3.20	.42
Institutional support	3.89	.17
Self-efficacy of mobile-based teaching	3.16	.35
Intention to integrate mobile devices	3.80	.16

To explore the influence of demographic factors on each category of the survey, ANOVA analyses were conducted to identify significant differences between the six categories. Results showed that male teachers scored significantly higher ($F = 4.39$, $p = .049$) in mobile device skills than female teachers.

5.3 Hypotheses Testing

The structural model was assessed to confirm if relationships specified by the proposed model were consistent with the available data. PLS algorithm was employed to examine the path coefficients, then a bootstrapping technique was used to estimate t-values. Another indicator of the predictive power of path models is to examine the explained variance or R2 values [43]. Figure 2 shows the PLS analysis results and presents the path coefficients, along with associated t-values. All significant paths are indicated with asterisks.

According to Fig. 2, the data indicated that Hypotheses 1, 2, 3, 5, and 6 were rejected. Additionally, mobile device skills were a significant predictor of self-efficacy of mobile-based teaching. Furthermore, attitude and technology belief, and self-efficacy of mobile-based teaching were significant predictors of intention to integrate mobile devices, which collectively explained 66.9 % of the variance.

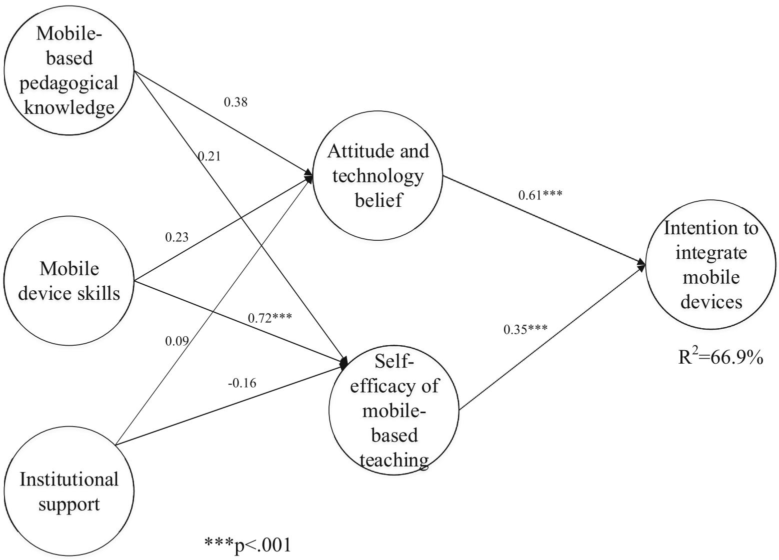

Fig. 2. PLS analysis results

6 Discussion and Conclusion

The purpose of this study was to investigate the key factors influencing teachers' mobile device integration in teaching. The results of this study provided two main conclusions: (1) that teachers' perception of mobile device integration with teaching is not satisfactory, and (2) that teachers' perception of mobile device skills is not proficient, especially among female teachers.

Additionally, findings indicate that teachers' mobile device skills is a strong predictor of their self-efficacy of mobile-based teaching. Therefore, teachers with proficient mobile device skills would be more confident in integrating mobile devices in teaching.

This study also suggests that teachers' attitude and technology belief, as well as self-efficacy of mobile-based teaching, are key factors influencing teachers' intention to integrate mobile devices in teaching. That is, teachers who believe mobile devices are better than traditional multimedia in delivering knowledge, or designing learning resources, are more likely to integrate mobile devices in teaching. These findings are consistent with previous research [44] which revealed that teachers' implementation of ICT was dependent on simplicity of computer use and perceived teacher self-efficacy.

Based on the empirical findings, K-12 teachers, school leaders, and researchers now have a broader context of knowledge specifically relating to the integration of mobile devices in teaching. Moving forward, in order to maximize the potential of this knowledge, it is clear that teachers need to be more open-minded towards mobile integration. Furthermore, it is necessary for school leaders to provide teachers professional development opportunities relating to mobile device integration. However, rather than focusing efforts on specific technologies, professional development experiences would be more effective when focused on modern digital pedagogy [16].

Beyond professional development, it is also essential that educational leaders cultivate a supportive culture where innovations are encouraged and valued. It is essential that opportunities be provided for teachers to experiment with mobile devices in teaching [45] and share the results of their personal exploration among their colleagues. Additionally, in order to promote teachers' attitude and technology belief, communication must be strengthened among school leaders, ICT coordinators, and teachers about the role and enhancement capabilities of ICT in education [46].

The limitation of this study include sample size and uncontrollable variables, therefore, this study is just a primary form of empirical research. Since additional variables (e.g., subject area, high-stake testing, etc.) which may influence teachers in terms of their intention to integrate mobile devices [47] were not included and analyzed, additional research on this subject in necessary. Researchers should conduct future studies using larger samples and incorporating additional variables, with both quantitative and qualitative research methods.

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User Evaluation of Language Websites as a Way of Students' Engagement into Blended Learning Process Case Study

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Abstract. The paper deals with an interdisciplinary field of developing language and digital competences in university students via usability testing of English websites by students themselves. The researched issue covers two areas which mingle and influence each other: functionality of web-sites and educational benefits arising from non-standard approach in the university setting where language is used as a tool not as a main goal to fulfil technical tasks. Comparison of the outcomes gained from the user-testing forms conducted by part-time and full-time students showed their positive acceptance of the new approach to getting acquainted with selected websites and readiness to their incorporation into the process of education. Students are given a way of getting the mastery of exploring language websites and learning how to navigate themselves in them, use functionalities like connection to social applications, practice tests or self-diagnose of language competence.

Keywords: Language educational websites · Usability testing · User satisfaction · Blended learning · Didactic

1 Introduction

The Internet is a current and trendy source of gaining knowledge via various patterns, approaches and experience. The paper deals with interdisciplinary field of developing language and digital competences in university students via usability testing of English websites by students themselves. This is another pursuit of scholars to motivate students in the specific area of blended learning in both virtual and face-to-face educational process. *This study discusses didactic approach to the engagement of students into the blended learning via optional activities arising from instructions to run usability tests of selected websites in an e-course of Professional English subject to presentation of findings during face-to-face classes.* Voluntary testing, in this case language testing, might be considered as game and can be characterized by two specific traits which are unambiguously technical possibilities and fun. The value of games is in their wide utilization for educational purposes as they can positively stimulate different human skills and personal development. Practicing language in a fun way can break barriers in students who feel either justified or just personal difficulties in mastering the

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language when utilizing diagnostic tests as a starting point for a proper selection of an international language test which will be adequate to student´s competences.

History and experience prove a professional fundament in blended learning at the university. There has been more than two decades of developing history in utilization of learning management system (LMS) in the process of education at the Faculty of Informatics and Management, University of Hradec Králové. All subjects of Professional English for both full-time and part-time students are run in the form of blended learning; combination of face-to-face classes and teaching/learning in language e-courses in the Blackboard virtual study environment. E-courses are actively and systematically used as a source of study material, an information noticeboard and as a forum. These e-courses are living bodies; they are enriched with students and teacher's contributions. Students contribute on both compulsory and voluntary basis. *User web-testing as a voluntary activity is discussed in this paper.*

The paper follows the standard layout: introduction, methodological frame with literature review, stating the goal, description of applied methods, tools, and assessed websites, the core chapter brings findings and conclusion forms the final chapter.

2 Methodological Frame

This chapter provides readers with literature review on usability testing and the role of games in the process of education, state of art, stating goals and hypotheses, applied methods and brief description of assessed language websites.

2.1 Literature Review on Usability Testing

The first user testing of English websites by English foreign language (EFL) students was run at our faculty eight years ago within a wide project on analysis of web language educational sites and their services [1]. Out of more than 200 foreign and local language portals ten English language websites were analysed utilizing web usability methods. User testing was conducted according to Jacob Nielsen principles with the standard *method of usability testing with just five users* to asses websites [2]. "Usability is a quality attribute that assesses how easy user interfaces are to use" [3]. Usability is defined by five quality components but for the purposes of this paper just three of them were followed: Navigation, Efficiency and Satisfaction. Principles of usability and a level of satisfaction play the essential role on consumer's loyalty with web sites [4]. Utilization of methodology applied in usability testing is becoming more widely used in university setting, e.g. assessment of university library's website [5]. Potential of the interdisciplinary field of digital literacy and language competence in EFL learning context is discussed in [6]. Authors claim that *website analysis facilitates logical thinking and contributes to the development of functional language proficiency* [6]. Last year the issue of website analysis was introduced to students as a game [7]. The value of game was highlighted; within the games students developed financial and language competences which are perceived as a standard and inseparable part of our current lives.

2.2 Literature Review on the Role of Games in the Process of Education

The topic of the contribution might be ranked among motivation activities in the process of education, stress-free activities enabling improvement of performance outside the barriers of standard curricula, e.g. *an online game approach for improving students' learning performance in web-based problem-solving activities* [8].

The role of game and fun is natural part of the process of education. The next part of the literature review brings a set of examples from both deep past and present time.

The value of game for educational purposes ranks among key didactic principles which were already stated in the 17th century in the first didactic masterpiece. Didactica Magna [9] was written by scholar and philosopher Johann Amos Comenius, the Teacher of nations. Didactica Magna discusses theorems that even now sound modern, natural and form fundamentals of didactics disregarding which philosophical paradigm is currently trendy, e.g. *purposefulness of learning*; systematic and logical approach; *learner's activity,* clear explanations; forming long-lasting knowledge; applying adequate methods, forms, examples etc. so that the learner could understand the learning content; *awaken emotionality within the learning process*. Don't these principles sound modern four centuries later? These 'archaic' principles are eternal still alive and efficient in the Information Age and fully fit new virtual space [10]. 'Principle of learner's activity' and 'Principle of fun' (game) in the process of education run like a red thread through entire contribution and in some way pay a tribute the scholar.

When we return to present time an inspiring article discussing the value of game we could find in the paper dealing with video games [11]. *Educational process is not just drill; there is no conflict between games and learning*. Lu Zhang and Junje Shang discuss the educational significance of video games and claim that in traditional teaching they could contribute to improve learning interest and motivation. They could even help to develop students' creativity and the ability to cooperate in the area of solving problems [11]. Authors' enthusiasm about the educational significance of video games is convincing in the way they present the relationship between gaining knowledge and video games. However the authors raise possible questions which are tacit knowledge, content design of the classes, assessment, etc.

2.3 State of Art

Virtual environment brings benefits like self-pacing and convenience which are highly evaluated by students [12]. To work at own pace, and time and place complying with the student's possibilities and needs contributes to a feeling of self-determination and independence. This study on website assessment is based on students' optional activities on their voluntary involvement into blended learning. Current findings fully correspond to last year's findings regarding to voluntary engagement into the learning management system (LMS) which reached 30 % of students. [13]. Figure 1 illustrates actual current activity of students this semester in the Professional English e-course for full-time students. Data were gained from LMS Blackboard from the students' activity trekking. Three areas in the forum are here presented; students can access and leave messages in topics Media, News and User testing of web sites. The striped bar shows students access into forum and the black bar their contributions, meaning their real activity. Great interest in usability testing can be seen – 90 % of students visited this forum, but only a quarter of all students got involved and participated in the project.

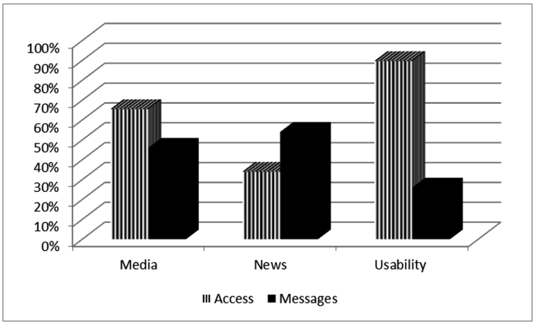

Fig. 1. Students' voluntary activity in forums, access and contributions

2.3.1 Setting Objectives and Hypotheses

The goal of the paper is to assess two English educational websites according to Usability Testing with Five Users method.

The sub-goal is to compare the outcomes of part-time students and full-time students to determine suitability of incorporation websites with diagnostic tests and self-test into the process of education.

Hypothesis H1: There will be higher rate of full-time students participating in the project of usability testing than part-time students. Part-time students are in their last year of bachelor studies so they will not have time "to play".

Hypothesis H2: Part-time students will vote for incorporating selected websites with on-line tests into the syllabus because the study time during the semester is limited just to two sessions.

2.4 Applied Methods and a Research Sample

Experimental strategies combined observation of five individual participants who performed the usability tests: five students of combined form of studies (part-time students) and five students of present form of studies (full-time students).

Students were given instructions on the usability testing in the e-course. The offer of websites consisted of 4 language websites and 3 geography websites. With respect to the amount of collected data just two websites Dialang [14] and English Exam [15] were selected, described and discussed.

Students downloaded the forms with tasks. Usability forms were created according to usability testing principles [3]. *Tasks were adapted to reflect the requirements on language websites gained from needs analysis that was run with students last year.*

User testing of language educational portals

Focused on English: **Test you language skills**

Dialang - **http://dialangweb.lancaster.ac.uk/**

General view of the server and its functions

- **What is the main mission of the server?** (Your first impression – max 1 min)

  Language testing

- **What functions or options does the server offer?**

  It isn't possible to accurately determine or specify from the first sight the functions.

	Time (min) search	**Yes**	**No**	**Web address**	**Other information**
Is entry to the website and testing free	10s	X			
Is registration necessary?	10s		X		
Is registration free?	---	---	---		
Is there a link to social apps? (if so, can you name the apps)			X	*I didn't find any.*	
Are instructions only in English or are there other language versions?	1min	X		*I found 18 languages, but I don't know if everything is in these languages.*	

	Time: finding the site + procedure description	Website address	**Time**: doing the test
Can you select test "**English vocabulary**" and try to do the test and submit answers?		http://dialangweb.lancaster.ac.uk/setals	6 min
Can you find "Contact"	*I didn't find a contact person*		2 min

Fig. 2. User testing form – general view and tasks

Figure 2 shows the *first part of the form, where users are asked to complete given tasks*. The extract shows the authentic form with filled answers in italics by a part-time student.

The second part of the form analyses websites from the navigation and design perspective in detail. Users are asked to answer following questions: What mission of the portal they can see now after completing the tasks, after getting familiar with them: For whom the web-site is designed? Is that a waste of time to explore the website? Are tests divided into categories (if so – how)? What are positives and negatives of websites? What functions does the server offer? Which functions approached you?

The last part of the form assesses websites from the user satisfaction perspective. Users select the level of satisfaction with websites on the scale of satisfaction from –5 to +5. They are invited to justify their choice or share opinions and benefits for education, fun, etc., on incorporation of similar websites with tests into syllabi of university subjects and on problems with completing tests.

Research accessible sample consisted of 41full-time students and eleven part-time students from the Faculty of Informatics and Management, University of Hradec Králové attending the classes of Professional English. 90 % of full-time students showed the interest in the research as mentioned above, see Fig. 1, but only 11 of them actively entered the research and submitted user-website forms assessing two to even seven websites. As for part-time students astonishing nine students out of eleven "entered the game". Involved students participated not only in the virtual environment but they also gave presentations on their experience on user testing, gave recommendations on pluses and minuses of web-sites and ran an expert discussion with their classmates.

2.5 Description of Analysed Websites

DIALANG. DIALANG is a language diagnosis system developed by European higher education institutions. It reports the level of skill against the Common European Framework (CEF) for language learning. History of DIALANG Project goes back to 1996. The tests are highly sophisticated but the web page design, icons and instructions are rather old fashioned, see Fig. 3.

Fig. 3. DIALANG home page

Main reasons for selecting DIALANG website were following: testing is free, there are different tests for different levels of learners comprising self-tests and placement tests, here are three different versions of tests for each language/skill pair in DIALANG: easy, intermediate and difficult. These websites are beneficial for students who need to take a language examination to get a certificate and aren't sure which level of exam to take.

English Exam. The English Exam website is a kind of mosaic of tests, see Fig. 4, contrary to the DIALANG website which is a comprehensive system taking a user through individual steps from placement tests to feedback.

Exam English web site was selected predominantly because it responded to one of the key requirements of students – to get prepared for international language exams. This web site in its home page presents its main mission "This web site is for people studying for an English language exam." Pages contain free online practice tests for the most important international ESL exams [15]. Users are provided with a general

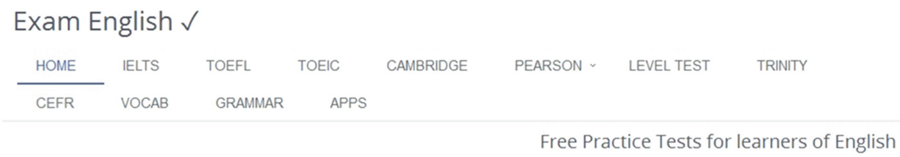

Fig. 4. English Exam home page

awareness on the concept of language competences CEFR. Another valued feature is that users can get the general knowledge on all these exams due to the table where all exams are compared by level. Websites offer self-placement test, users can check their level with two level tests; one is Grammar & vocabulary level test and the other Listening level test. This websites doesn't stagnate. Its developers also produce mobile apps to help to prepare for English exams.

3 Findings

3.1 DIALANG

DIALANG website was tested by 5 part-time students and 5 full-time students. As for findings relating to *navigation and fulfilment of tasks there are no discrepancies between these two groups*.

There was one drop out user, a part-time user who gave up testing because of enormous dissatisfaction with DIALANG website. He wrote into the field of the first task on the mission of web sites: "These websites are strange, they aren't user friendly, it is a waste of time I would prefer http://www.stuff.co.uk/english.htm."

Assessment of web sites from the first impression was the same: all users stated that the main mission is "testing or evaluation of language skills", one full time student expressed dissatisfaction with the design added: "Too many buttons and 'blablablaing'. Little bit confusing. It would be easier just to click and do the test."

All beside the dropped out one completed the tasks within the time span of 30 s to 1 min. Just one user made a mistake in the registration task.

All identified that there is no link to social applications which got reflected in the final evaluation of one user who missed this link which is currently a standard feature of websites.

The only problem users faced was the task to finding the contact even if they spent 3–5 min on it. (Note: Placing the task on the contact into the user testing form stemmed from the students need analysis as a standard function of website). None of part-time students found the link to contact person. Only 2 full-time students completed the task.

When it comes to the Language test, there was a wide time-span to do the test but the results in both groups were comparable. The Fig. 5 shows comparison of the two groups. Minimum was 6 min in both group to complete the test and maximum 16 min also in both groups. 0 min refers to the drop out user.

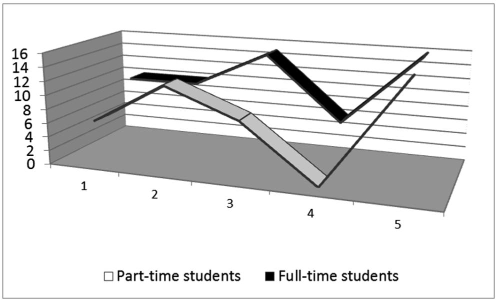

Fig. 5. DIALANG - Time to complete the vocabulary test

The enormous discrepancy can be found in the assessment of the Level of satisfaction, see Fig. 6. 2 full-time students gave +5 points - the highest rating contrary part-time students were neutral and once gave the lowest rating.

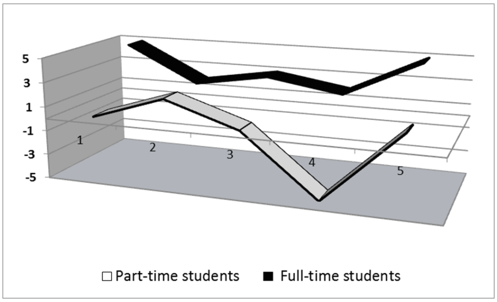

Fig. 6. DIALANG - Level of satisfaction in full-time and part-time students

An interesting thing calling for further explanation is that part-time students who were more negative in the assessment were *quite enthusiastic about incorporating diagnostic tests into the process of education:*

Part-time students' comments on language websites and university environment follow: "*Yes, incorporate, but it depends on University specialization, so we should focus on economic terms and environment. Yes, it is fun. Definitely yes. Definitely yes for full-time students. But for us? – there is a problem with time, Yes, to compare our entry levels at the beginning and at the end of semester*".

Comments and recommendations of full –time students: "*Yes, especially the placement test, The benefit of website is quite big but for me the website isn't clear even if it is easy, I would recommend English Stuff website instead, Yes, but the website shouldn't be the main educational part of learning English, Yes, it makes sense to do tests, it helps to refresh, revise, repeat and enrich vocabulary*".

The following complex table brings all users notes on positives and negatives of the analysed website and will partly explain their level of satisfaction (Table 1).

Table 1. Table of positives and negatives

Perceived positives		Perceived negatives	
Full-time	Part-time	Full-time	Part-time
1. Easy navigation	Nothing	Nothing	Confusing
2. Simple websites and possibility to save the test results	Instructions in many languages, good feedback function	Only few buttons, yet confusing, no link to social nets.	Not in Czech language
3. Choice of languages	Benefit in practising language nothing else	Sometimes worse clarity, many labels before testing,	Dissatisfaction with listening - no possibility to repeat
4. Nothing mentioned	Nothing positive	Poor graphics and slightly worsened clarity at the expense of web graphics	Nothing positive
5. Good practising of grammar	Simple and clear		Not enough materials, there are better websites

3.2 English Stuff

Tasks in the practical language part of the user form slightly differ so that they could reflect the different mission and content of the websites. All users accomplished the tasks to find the link to social nets and find other language versions. Finding and accomplishment of the selected Cambridge test was also done by all participants. There were no differences in time spent on doing the test between both groups; time varied from 3 to 16 min (to be precise in part time students it was 5, 5, 7, 15, 16 min, and in full-time students 3, 6, 6, 8, 16 min). Category of time is important but much more valuable is assessment of the level of satisfaction.

Figure 7 shows an extract from the testing form the filled by a diligent full-time student.

There is a near-consensus in assessing the level of satisfaction in both groups. Both groups rank this website high in the aspect of satisfaction: part time students: 4, 5, 3, 5, 3 and full-time students: 5, 5, 4, 3, and 5.

Summary of part-time students' opinions on English Exam website:

- all students would incorporate this website into the language classes
- website is interesting, free and clear
- The dissatisfied user with DIALAG wrote that he would return English Stuff.

Summary of full-time students' opinions on English Exam website:

- Easy navigation system (3times), clarity (4-times),

Is registration free?		yes		http://www.examenglish.com/index.html
Is there a link to social apps? (if so, can you name the apps)	One minute	yes		http://www.examenglish.com/ Facebook, twitter, google +
Are instructions only in English or are there other language versions?	Three minutes	yes		http://www.examenglish.com/index_es.php Spanish, French, Chinese

	Time: finding the site + procedure description	Website address	**Time:** doing the test
Find and do the test „**Cambridge English Advanced (CAE) Reading & Use of English 1** You should complete this activity in 15 minutes.	Two minutes I first read the article. Article I tried to translate. Finally, I added Answers.	http://www.examenglish.com/CAE/cae_reading_use_of_english1.htm	Eight minutes
What is B2?	B2 is one of the CEFR levels described by the Council of Europe. He can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of	http://www.examenglish.com/B2/index.php	XXX

Fig. 7. English Exam usability form with adapted tasks

- One user described positives and negatives in a smart way: *"No pictures ☹ Low graphical level ☹ big internet advertising on the left ☹/simply, intuitive, clear page ☺, A lot of information, exam ☺ A lot of tests☺".*
- Two users highlighted the function of bookmarks enabling users to move and find easily through the visited pages.
- Two users referred to the link to Cambridge Publishing House, language textbooks from this publishing are widely used in our educational system.

4 Conclusion and Practical Implication

Blended learning is in this case understood as fruitful combination of face-to-face classes supported by virtual study environment where activities and outcomes lead to the successful completion of the subject. The paper discusses the blended approach on the example of usability testing of language web-sites. It is common practice that language teachers acquaint students with the amount of appropriate additional resources and web links, this paper shows and innovative way to this issue where the process of students' learning is based on their own exploration. In the virtual space students are given instructions to work out and submit own assessment of web-sites. During face-to-face classes students present their experience and findings in the form of an expert presentation which covers both desirable levels language and informatics.

The goal of the paper was to assess two English educational websites according to Usability Testing with Five Users method. Design, conduct and final results of the usability testing were described and illustrated. The pedagogical aim of implementation of this approach was to get students involved via method which corresponds to their specialization. Based on the findings we can state that this approach is an effective way of learning because students get acquainted with the web-sites beneficial for their language educational purposes, learn how to describe the design of web-sites and learn how to discuss and justify their evaluation. The navigation in DIALANG website was easy. The only problem was identified in finding the contact person; none of part-time students found the link to the contact person and only 2 full-time students completed the task. Other problem in design represented rather old-fashioned icons and the lack of the link to social nets. As for English Exam website no faults were detected. Appreciated functionalities were found bookmarking and links to English textbooks.

The sub-goal was to determine suitability of incorporation websites with diagnostic tests and self-test into the process of education. Both full time and part time students agreed with including websites into the educational process, English Exam website gained higher preference.

Hypothesis H1 was rejected. Based on the findings there was higher rate of part-time students participating in the project of usability testing than full-time in spite of the fact that part-time students are in their last year of bachelor studies overloaded with preparation to final exams.

Hypothesis H2 was accepted. Part-time students will vote for incorporating selected websites with on-line tests into the syllabus.

As for practical implications, it can be stated that that usability testing of language websites fits university setting and can be incorporated into the process of language learning/teaching process. Students are given a way of getting the mastery of exploring language websites and learning how to navigate themselves in them, use functionalities like connection to social applications, practise tests, self-diagnose their level of language competence, in other words get beneficial information or just practice the language in the virtual environment which they are familiar with being the net-generation. Teachers are given a tool which is based on proven basic principles but at the same time the method of usability testing is flexible; tasks on usability testing forms can be adapted in accordance with the focus of the research or eventually the educational goals of the teachers applying this method in language classes bringing students to a new way of exploring selected websites.

Usability testing web-sites, in this case usability testing of language web-sites serves as an example of applied language and opens further dimension for the didactics of teaching/learning languages.

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Experience in Blended Learning

Enhancing the Blended Learning Experience Through Crowdsourcing: Applications to Management Education

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Abstract. The world of blended learning is now becoming the new norm throughout the management education universe. Under growing pressure from a variety of stakeholders, business educators are increasingly turning to the blended learning model as a vehicle to provide world-class education. The approach being adopted in many programs is to engage faculty and students in a virtual crowdsourcing learning experience via the blended learning model. Crowdsourcing as applied to business education is the process of connecting students and faculty with a broad-based group of both internal and external resources for the general purpose of problem solving, developing new skill sets, and measuring results. The purpose of this article is to identify the growing opportunities for crowdsourcing in management education and to highlight specific implementation strategies for helping facilitate this revolutionary learning process throughout the community of practice.

Keywords: Crowdsourcing · Management education · Blended learning

1 Introduction

Management education is undergoing a seismic change in both content and delivery as a result of globalization, new learning technologies and changing demographics. The blended model is front and center in this ongoing learning revolution [10]. As we all know, blended learning combines the best practices of the classroom with the power of the Web. Today, the approach being adopted in many business schools is to engage faculty and students in the blended learning paradigm using crowdsourcing. As applied to business education, crowdsourcing is the process of connecting students and faculty with a broad-based group of internal and external resources for the general purpose of problem solving, developing new insights, and enhancing decision-making skill sets [19]. This learning strategy is based on a collaborative and constructivist approach that enables students to better meet the evolving demands from the business community. For many years, the private sector has embraced crowdsourcing as an important strategic vehicle [9, 11].

Interestingly, a little over 300 years ago, the British Parliament passed the Longitude Act of 1714. This legislation called for a solution to the problem of determining longitude at sea to within one-half of a degree or roughly 70 nautical miles at the equator. The

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prize was 20,000 lb or about $3 million (USD) in today's currency. This initiative was the result of both naval and merchant disasters that occurred due to poor navigation and the need to shorten oceanic travel times. The British establishment had somewhat given up on finding a solution to this vexing challenge and so they reached out to the general population for help. The solution came from a most unusual source: – a London watchmaker – John Harrison – who spent the next 40 years perfecting the chronometer [20]. Thus, the process of crowdsourcing was born!

Crowdsourcing is inexplicably linked to Frigyes' six degrees of separation theory [3]. This theory suggests that you can connect with any other member of a network, like the Web, through no more than five intermediates. For example, if you are connected to 100 links on the Web and these links in turn are connected to another 100 links then in five steps you are connected with 10 billion links or more than the human population of this planet! This is the fundamental tenet behind the crowdsourcing paradigm. Several assessments have been conducted on this theory, which have reasonably validated the six degrees estimate [4].

> *The increasing complexity and changing dynamics in the business environment caused by accelerated globalization have made it difficult for business schools to determine how to incorporate these changes in their curricula. Teaching general phenomena in this new global environment is inadequate to prepare business graduates to be globally competitive. Business schools should design customizable curricula to assist students in identifying and learning critical skills, knowledge and attitudes to compete in their targeted global market* [13].

Crowdsourcing can enable students to hone their problem-solving skills by accessing a large pool of talent via the assessment process. This learning strategy is based on a collaborative and constructivist approach that enables students to more fully develop the skill sets needed to meet the evolving demands from the business community [8]. To this end, the practice of crowdsourcing using social media is receiving increased attention throughout academe [12, 18].

This level of student-and-faculty access to the global body of knowledge becomes a powerful vehicle to enhance learning opportunities and outcomes. Some key characteristics associated with the use of crowdsourcing in academe include: (1) Encourages self-forming and self-governing groups, (2) Shares common interest or learning goals among members, (3) Creates new knowledge, and (4) Promotes learning in a real-time context. This paper's primary contribution to management education is to outline how crowdsourcing can be used to enhance the learning opportunities and outcomes.

> *The beauty of new social and digital technologies is their immediacy, reach and flexibility. Alongside traditional teaching techniques, social media can be continually developed around any topic and incorporate current business events in the learning process as the events themselves unfold. Discussion can be guided initially by faculty, but be managed by students and monitored and supported by the institution itself. This sort of teaching can promote the business school globally online as a forward-thinking online and innovative institution* [21].

2 Discussion

Today the business community is using the Web to increase consumer participation through enhanced network interaction. Typically, consumers' personal data is exchanged for widespread product and service access that is both convenient and timely. This web-centric framework can be applied to management education wherein the consumer becomes the student. In this context, the student trades prior performance and background data for customized content and access to like-minded collaboration groups. For example, the networking and social communication capabilities of the Web offers a variety of learning styles (e.g., blended), provides for real-time learning, helps facilitate an online community of practice, and increases opportunities for faculty-student and student-student interactions [15]. A key challenge to the management education community of practice is to keep pace with the rapidly changing technology landscape. The Web represents a major step forward in the learning process by permitting individuals and groups to interact and collaborate as creators and distributors of content.

> *Students must take ownership of their own learning in exchange for multiple modes of engagement in familiar online social venues. At the same time, students must accept communal responsibility and provide mentoring in a quid pro quo environment where payment is non-material. Empowered by proven techniques in social learning design and crowdsourcing, these new responsibilities promise more effective and efficient learning outcomes* [1].

This approach exemplifies the andragogical learning philosophy introduced by Malcolm Knowles in the 1960s [5]. Three key assumptions associated with the andragogical paradigm are: (1) Learning is problem-centered rather than content-oriented, (2) Learners are internally motivated and self-directed, and (3) Learners bring life experiences and knowledge to the learning process. These axioms are consistent with overall Web structural design. Some examples of web-based applications in a management education learning environment include social networking, collaboration, co-production, cloud computing, and simulations. Student co-production, which is based around their personal experiences, is another example of the andragogical model, which brings numerous benefits. In this context students and student teams participate in the design and delivery of specific course and curriculum content. The co-production model can lead to increased student satisfaction, reduced student anxiety, and improved educational outcomes. This andragogical perspective further enhances the value of the virtual learning community of practice and can be enhanced through the use of social media. Many students now consider multi-tasking, customization, collaboration, and speed to be the norm. Students tend to dislike the classic lecture-based, information-dated, response-deficient silos of learning and instead are looking for a pro-active learning environment. Management education's use of web-based technologies has resulted in the development of new student capabilities including: collaborative learning, independent learning, problem solving, team work, and a sense of global community. This is a type of skill set that is of growing interest to the business world. The results from a range of studies involving online simulations and related experiential environments illustrate the effectiveness of these learning systems in clarifying the complexities associated with modern business management and improving students' business decision skills all within this same context [16].

Nevertheless, there is still a gap between the business community's needs and the business graduates' skill sets. What business leaders are looking for are web-savvy, problem-solving graduates who can begin contributing immediately. As a result business schools are under increasing pressure from both the business community and students to offer cost-effective programs. The rising cost of higher education coupled with a stagnant job market continues to plague many recent graduates. The unemployment rate for new graduates is considerably higher than the national average. Furthermore, the level of student loan debt in the United States has reached an all-time high; in fact, it now exceeds both credit card and auto loan debt.

To meet these challenges, the traditional method of knowledge transfer that features the constraints of fixed location, time, and learning pace is being replaced with a more user friendly and customized style based on the blended learning model. In that regard, a number of surveys have been conducted on both faculty and student perceptions of blended learning nets, which revealed:

- Offer a high degree of student interaction and collaboration that can be more effective than traditional classroom methods
- Represent a long-sought solution to the ongoing challenges associated with better aligning graduates with the dynamic needs of the business universe
- Provide the learner with a purposeful entry to web-based resources and thus to a new era of learning technologies
- Underpin the development of new patterns of relationships between education and business through virtual arrangements
- Support the growing interest in sustainability through the reduction of student commuting and the transition from printed materials to electronic materials

A crowdsourcing-based, blended-learning curriculum permits more business students to access the growing body of technical know-how that will allow them to remain competitive in an ever-increasing global marketplace [24]. This approach not only builds learning capacity in the student, it is also highly measurable and provides near real-time feedback. To that end, crowdsourcing removes the attenuated feedback found in most traditional learning processes. This ongoing reformation, supported by learning analytics, is an active demonstration of 21st century business practice within the growing knowledge economy. Some specific characteristics of crowdsourcing-based learning include:

- Promotes self-forming and self-governing groups
- Shares common interest and learning goals among members
- Accesses new knowledge
- Enhances learning in a real-time context
- Develops skill sets that mimic the business community
- Expands team oriented problem solving skills

Overall, the use of crowdsourcing to identify and fill the dynamically changing gaps between the business universe and the skill set of business graduates represents the new learning zeitgeist.

> *The Internet has altered many of the traditional power relations in education. Tasks that were previously the domain of faculty are now under the control of learners: searching for information, creating spaces of interaction, and forming learning networks. Through the use of social media, learners are able to engage and interact with each other and with researchers and faculty* [17].

Recent data suggests that crowdsourced peer-to-peer assessment (unlike self-assessment) offers ratings that are highly correlated with instructor assessment and demonstrate strong inter-rater reliability [2]. Specifically, the results show that crowdsourced peer-to-peer assessments are perceived by students as fair and accurate. The goal of formative assessment is to monitor student learning to provide ongoing feedback that can be used by instructors to improve their teaching and by students to improve their learning. More specifically, formative assessments help students identify their strengths and weaknesses, and target areas that need additional work. For example, crowdsourcing-based problem solving and reflective learning can be enhanced with the use of a non-structured social media environment based on self-managed learning groups [6]. Students reported that the use of social media contributed to successful course outcomes and an overall positive learning experience. Social media based crowdsourcing can open up multiple options for adding new dimensions to learning and knowledge acquisition by allowing students to connect in both formal and informal learning settings [26].

In an academic setting, crowdsourcing can enhance opportunities for students to access previously inaccessible intellectual capital [23]. This outreach system offers a forum for faculty and students to present their ideas and problem-solving abilities in front of an entire community, whereas these ideas are frequently lost in translation when transmitted through traditional institutional channels. Implementation of this crowdsourcing-based strategy requires a broader view of the student learning process. It necessitates faculty and students taking ownership of the process and being fully engaged. Faculty needs to understand the importance of classroom level calibration, the methodologies to achieve this and the larger questions the degree programs are asking based on performance outcomes. Faculty needs up-to-date professional development, given the ongoing rapid changes in learning technologies. As students become more technologically savvy, they will require faculty who are more sophisticated in the application of new learning systems. Thus, faculty training and development remains a key element of the virtual collaborative learning universe.

> *Students must understand and use learning targets, set their own learning goals, select effective learning strategies, and assess their own learning progress. And as students develop into more confident and competent learners, they become motivated (energized) to learn, increasingly able to persist during demanding tasks and to regulate their own effort and actions when they tackle new learning challenges* [12].

Engaging faculty, educational researchers, and administration in the crowdsourcing-based paradigm is essential for ensuring success in the implementation process. This is particularly the case for learning outcomes involving multi-disciplinary problem solving. There are a number of factors that need to be addressed so that the faculty can successfully engage in this activity, including: training, development, and incentives [7]. Faculty-driven collaboration networks can help facilitate the adoption of the crowdsourcing strategy through access to community best practices [16]. Learning innovations like crowdsourcing are most likely to be accepted and used by the majority of management educators if success is experienced early on. This objective extends to the peer network, both within and outside the institution, thereby magnifying the impact on adoption and diffusion of the social media learning paradigm [22]. To that end, some specific implementation issues include: (1) On-going peer support, (2) Real task activities, (3) Ownership and identity, and (4) Design philosophy. As it turns out crowdsourcing networks are fit for purpose. The purpose determines how the network is structured and used. Governance is the process for managing both joint and individual work and has both structural and behavioral components. The adoption of a crowdsourcing learning framework should be based on a number of factors including ease of use, functional value, costs and membership access. The ongoing evaluation of student readiness provides the focus and feedback needed to support the institutions' capability to maintain superior levels of service. On the expense side of the equation, crowdsourcing offers a relatively inexpensive way to tap into the resources and opinions of a committed community of learners. The transition to a crowdsourcing learning universe in management education presents a number of challenges including: (1) tracking the evolving nature of mobile learning, (2) supporting a fragmented landscape, (3) processing a growing amount of data and information, and (4) accounting for varied institutional demand and usage.

The cloud-based blended learning model requires competencies that extend well beyond traditional instructional methods with a shift toward learner-centered approaches, wherein faculty act more as facilitators of learning rather than distributors of content. Competencies in online pedagogy and implementation allow faculty to be more effective as technology evolves. In this regard, a number of research efforts are under way on how business schools can leverage crowdsourcing to "close the loop" on student learning and success.

> *Shifting presentation of course content from a traditional approach to a blended learning approach, while keeping the intellectual content and course evaluation consistent, lead to an increase in student learning as assessed by exam performance and overall course point totals. Moreover, student feedback about the approach was very positive and students overwhelmingly preferred the blended approach to a more traditional course structure* [14].

Table 1. Evolution of web-based learning for management education

Characteristic	Web 1.0	Web 2.0	Web 3.0
Content	Read only	Interactive	Crowdsourced
Instruction	Faculty-student	Faculty-student Student-student	Faculty-student Student-student Collaborative groups
Learning process	Fixed pace	Co-producers	Agile
Outsourcing	Low	Low	High
Business perspective	Graduates need significant retraining	Graduates need some retraining	Graduates possess entrepreneurial problem solving skills and spirit

Table 1 illustrates the evolution of web-based blended learning from 1.0 to 3.0 in terms of several key characteristics. Internet learning started with Web 1.0, where users were limited to the passive viewing of content. Web 2.0 represented a major step forward in the learning process by permitting individuals and groups to interact and collaborate as creators and distributors of content. With the advent of Web 3.0 the opportunities for improving the learning process are literally unlimited through the use of crowdsourcing. Often the term Semantic Web is used to describe this development. The Semantic Web is characterized by two key features: (1) establishing common formats for the integration and combination of data gleaned from diverse sources, and (2) formulating language for recording how the data relates to real world objects. The transition to Web 3.0 in management education will rely heavily on the use of the crowdsourcing paradigm.

3 Conclusions

The global economy is exerting ever-increasing demands on our business graduates. Students engaged in a program of management education need to develop capabilities to meet the challenges of the business marketplace, especially during these difficult economic times. A crowdsourcing-based, flexible and dynamic curriculum represents a key ingredient in meeting these ongoing challenges. Crowdsourcing helps assist faculty, students, student teams, and the business community, often in small groups, to construct and share knowledge. The development of group problem-solving skills are essential, since business managers are looking for graduates that are both web-savvy and have the capacity to work with others. The advent of Web 3.0 will further increase opportunities for virtual collaboration learning. This technological revolution will enable students to become even more creative and passionate in developing a learning identity and in enhancing their problem-solving skills, which in turn will help our students succeed, both in the classroom and in the workplace.

The three C's of modern creativity are community, crowdsourcing and co-creation [25].

Teaching students self-directed learning skills provides benefits that outlast individual courses and programs. An individual self-directed approach is insufficient, however, given the fast pace of change students will be encountering in their professional lives. Communities of practice combine self-directed and collaborative learning to meet the challenges of today's dynamic business environment. The increasing use of crowdsourcing via social media in management education will provide students and faculty access to the wider educational community of practice. Specifically, students and student groups can contribute directly to online discussion forums and share work for peer review in a manner similar to the current practices of the business community. Furthermore, the web-centric learning paradigm helps to increase student participation and promotes greater collaboration and deeper learning. A key challenge for the community of practice is to identify the best crowdsourcing practices such that students are motivated to contribute and participate more in the learning process.

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Convergence and Divergence in Blended Learning

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Abstract. Recent technological advancement in movable gadgets at more affordable prices, much improved access to higher speed internet, changing communication behaviors, and availability of accessibility of information have expanded an early tech-dependent form of blended learning in higher education worldwide. An examination of recent changes in higher education points to apparent resemblances of significant impact from blended learning. As an alternative approach of a traditionally defined educational delivery process with the help of technology, blended learning finds its influence in a much wider spectrum in higher education. This paper attempts to re-define blended learning as a multi-faceted expectation of higher education with four postulated features. A culture-based perspective predicts slower acceptance of blended learning in Chinese higher education system than in the U.S. higher education system. The paper argues that internationalization in higher education would greatly facilitate the acceptance of blended learning, but with a slow pace for a small number of early participating institutions.

Keywords: Blended learning redefined culture easy access to technology

1 Introduction: Early Activities of Blended Learning

With the emergence of technology advancement in the early 90s, adoption of learning management platforms (ECollege, WebCT, Blackboard, etc.) on many U.S. college campuses created an opportunity to integrate technology-enhanced learning platforms with the mainstream curriculum design and delivery: 24/7 access to enhanced course depository functions, extended interactions for students through online threaded discussions and built-in whiteboards, convenient submission of course assignment through drop-boxes, easy management of student learning and assessment activities through online tracking and grades book management functions, and enhanced students management of course enrollment and tracking of individual student course activities [11, 14]. In a way, it could be said that U.S. higher education became an early adopter of blended learning, especially in instructional delivery and course management.

Two major individual-driven motivations could be identified for early adopters: desire to utilize technology to enhance the teaching and learning processes, and finding ways to reduce total time spent physically teaching in the classroom. More and more students began to have access to technology and the internet, which turned into an expectation of students for the integration of technology with routine learning practices [1]. Early tech adopters extended their appeal to attract students to their sections of

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courses through the adoption of course learning management platforms in re-designing their courses and course delivery, with mixed success [3]. The other individual-driven motivation was found in the attempt by some faculty members to gain more time out of their classroom teaching for research by re-designing their regular courses into a hybrid format, where a small portion of the face-to-face class meet was carried out in the online environment. Students would not need to come to the physical classroom during that portion of the class schedule. Instead, they would do whatever was assigned to be completed online [16].

Those two individual-driven motivations were closely accompanied with two institutional drivers: an opportunity for the institution to utilize this blended learning design and practice to expose students to the use of technology as a needed college experience in the technology laden world, and to explore more efficient resource utilization (additional classroom spaces created from hybrid classes and technology fees charged for taking those hybrid courses) [1, 15].

Such early blended learning design also served as a stepping stone for the launch of large scale e-learning on many campuses as part of their strategic initiatives in that the design and implementation of hybrid courses expected those engaged faculty members to re-consider essential skills as well as understanding of blended learning in higher education [8, 10]. In the process of increasing popularity of such technology-education integration, fundamental issues and pedagogical principles echoed their importance with those who were involved with such blended learning endeavor.

Blended learning then was recognized as a course that utilized relevant internet technology in its delivery, execution, interaction, and evaluation, in addition to a certain proportion of in-person contact in the classroom. Terms such as “blended” and “hybrid” were used to describe such re-designed courses [16]. Pedagogical principles served as guides for such web-enhanced course development. It was recognized that the use of technology was to enhance, rather than to replace, teaching. This recognition led to faculty development on many campuses to focus on the integration of pedagogy and blended learning. Faculty development workshops emphasized discussions and hands-on activities on topics of designing e-interactive activities, e-assessment, e-management, and time management.

Recent technological advancement in movable gadgets at more affordable prices, much improved access to higher speed internet, changing communication behaviors, and availability of accessibility of information have exerted significant impact on higher education: what constitutes knowledge acquisition, how higher education would define core attributes for today’s college students, and how higher education would respond to increasing public accountability for what higher education does and how well it does it [4].

It is against this broad background that this paper attempts to propose the need to re-define blended learning through four postulates. This re-definition of blended learning intends to serve as a reminder that higher education as a special social domain can and will stand the test of time as well as societal changes to maintain its academic integrity as a profession; however, there is a need to academically and strategically incorporate such changes into its internal transformation and capacity development.

2 Blended Learning Re-defined

Early emergence of blended learning has made its way into higher education by becoming an alternative delivery of content. Its popularity and acceptance is greatly enhanced with constant technology advancement and its access by the masses. It would not be too much exaggerating to make a claim that blended learning has successfully merged technology and education in making a revolutionary impact on higher education (Brook, 2016) [2]. A close examination of recent changes in higher education points to apparent resemblances of such impact from blended learning. Blended learning as an alternative part of a traditionally defined educational delivery process with the help of technology has now found its influence in a much wider spectrum in higher education.

To attempt to capture the scope and scale of such influence, blended learning is to be re-defined as a multifaceted expectation of higher education with the following four postulated features:

2.1 Postulate One

Blended learning for college degree completion will be recognized as one other way of obtaining college degree and will remain so for higher education.

College degree completion will be recognized from two types of access to degree obtainment: that based on seating time (input-based), and that as determined by accumulation of prior learning experiences (output-based). The former has been serving as the dominant and trusted platform for determining college degree completion. However, an increasing number of higher education institutions have also experimented with alternative ways. An early practice was through the evaluation of individuals' prior work experiences to count as credits for their degree completion requirement. Those individuals would compile a portfolio with their prior work experiences and submit the portfolios for evaluation for college credits.

Currently, a similar practice called **c**ompetence-**b**ased **e**ducation (CBE) where individuals are evaluated of their competencies to determine if credits would be awarded is now being included in the regional accreditation standards in their accreditation processes of U.S. institutions of higher education. Such practice of determining credits for college degree completion is an example of how the evaluation of college degree completion is blended. Formal learning based on seating time in a classroom is now substituted with alternative ways.

In a way, learning in such blended format (evaluation of input-based information and of outcomes-based information) has created a revolutionary move whose profound impact is still beyond our understanding.

2.2 Postulate Two

Blended learning in educational instruction is characterized as multi-faceted in delivery and learning with emphasis on interactivities (between teaching staff and learners, and among learners) as well as on artifacts (manifesting the understanding and application of knowledge acquired).

The teaching and learning processes are expected to be of three apparent features: multi-methodological in delivery by the instructor, frequent interactive for deep learning by the students, and instant formative feedback in assessment by both the instructor and the students.

The use of technological gadgets and platforms (hardware) as well as educational packages and programs (software) will continuously enable blendedness in pedagogical practices in the teaching and learning processes. Even for the traditional delivery practice of lecturing, the instructor will be able to utilize a variety of technology-enabled resources in accessing information and presenting information in an array of displays (language, graphic, dynamic, interactive, and virtue reality).

Division of labor in the teaching and learning processes between the instructor and the students manifests another feature of blendedness, i.e., the emphasis on engagement of the learners through a variety of interactivities [13]. College will become a place where human capacity equipped with educational-fitting technologies would nurture maximum learning desire and engagement, empowering the learner for deep learning. In a way, it could be said that the learning centrality could see its full realization in such technology-enabled learning environment today.

Constant adjustment and progress in the learning processes would greatly benefit from timely and frequent feedback and evaluation (National Research Council, 2001) [12]. For education purposes, both summative and formative feedback would be needed. The relatively less frequent use of formative feedback in education will be improved with enhanced technological-platforms for assessment in the learning processes. Blending both summative and formative assessment practices would make college learning dramatically different in a world of big data and technology.

The demonstration of learning outcomes by students will benefit from technological platforms and Apps that allow the learners to showcase their learning outcomes in a variety of artifacts. The richness of those artifacts will manifest what has been learned, and how well the learning is. Such richness will show how students can blend the content of the artifacts as well as their presentation with the help of technology.

As described earlier, the use of technology created the first opportunity in higher education to enable blendedness in pedagogical practices in the classroom. It is more than a simple replacement of the “traditional” with the “modern” means in educational delivery. The utilization of technological platforms in teaching and learning has enriched and expanded the vision of how education can be done differently and more effectively, hence blended delivery.

2.3 Postulate Three

Blended learning in evaluation is more holistic both in assessment design and dimension. It is enhanced and supplemented with assessment triangulation. More emphasis is placed on direct evidence from assessment design and learning outcomes, with indirect assessment activities expected to provide more evidence.

Contemporary public accountability of higher education is asking for more evidence of quality in what the higher education has done with the public funding for education.

The responsibility to provide such evidence has led the academia to re-think and re-design its mainstream evaluation practices, namely, more holistic evaluation in addition to classroom grades.

This third postulate is closely intertwined with Postulates Two and Four. Rich artifacts that result from blended learning processes are collected and presented to demonstrate intended learning outcomes. And those learning outcomes are also to be assessed by stakeholders who are outside of the mainstream college environment, namely, employers. They have a deep interest in how well college students have learned and can do with what they have learned. In addition, students are also invited to be part of the assessment process where they provide their own evaluation of their performance to determine how well they have met pre-determined learning outcomes. Involvement of students in the assessment processes presents new understanding of what assessment serves: in the interests of the learners, assessment is not only of their learning, but also for learning and as learning. This value-added perspective of what assessment can be of value to the learners again demonstrates varying perspectives.

Such triangulation can be seen as a “blended assessment” practice in that perspectives from multiple angles are collected to make the assessment more meaningful and more value-added.

Blendedness is also found with the types of assessment information needed to evaluate and determine quality of educational outputs. Direct assessment information is now supplemented with indirect assessment information. The latter includes information of the learners’ learning experiences while in college as well as their employment experiences. Both types of information are collected through surveys and questionnaires (indirect assessment evidence). Such indirect assessment evidence, while not to replace direct assessment information, has become crucial in supplementing evidence of student learning outcomes that is gathered through a variety of course-based assessment platforms (direct assessment evidence).

2.4 Postulate Four

Blended learning manifests itself in graduate attributes in that those desirable attributes comprise of a core of elements believed by the institutions as essential supplemented with additional elements linked directly from specific and personal expectations.

Society is probably the first factor that influences the types of desirable attributes of college graduates. Characterizing those societal-related attributes is found in articulations of intended learning outcomes to assess students’ learning outputs, for instance, critical thinking, analytic competencies, team work, pluralistic views of the world, to name a few. Those attributes complement those essential academic-favored attributes such as domain knowledge acquisition, application of such knowledge, and academic research competencies.

Disciplinary expectations become the next factor that inserts its impact on college graduate attributes, for instance, employment loyalties, professionalism, and career specific capacities. Those attributes find themselves more fitting with colleges whose missions focus more on applied learning. With such institutions of higher education, articulation of graduate attributes often receives feedback from employers.

Personal expectations would be a unique source of motivation as a relatively new comer of stakeholders. Students pay for their education, and increasing number of enrollment in higher education drives the academia's transformation from an education for the elite to an education for the masses. Return of Investment (ROI) from students and their parents has seen more integration of personal expectations into intended learning outcomes for college graduates. Evaluation of how well such personal expectation-based attributes are being met has become an important indicator of quality of education programs for students, namely, satisfaction factor (part of the expectation to meet the needs of the students) in the assessment of quality of any educational programs.

It is no surprise to see huge blendedness in articulating such a variety of graduate attributes that are in the interests of several stakeholder groups. Blending the expectations from all the interested groups characterizes blended learning as unique.

3 Destructive to Higher Education?

Blended Learning can be said to be destructive in four areas in higher education: destructive to the long-held belief of how a college degree completion should be evaluated, destructive to the current curriculum composition, destructive to the long-traditioned teaching and learning processes, destructive to the dominant classroom-based course evaluation of student learning, and destructive to how a college graduate should be like.

Seating time as an input-process will remain dominant as higher education's traditional channel for granting academic degrees. Such privileged academic degree confirmation has been protected by government, academic institutions, and recognized and accepted by society at large. Any other form of granting college degrees would deem falsified (degree mill). A case in point is the experiences with e-learning during its infancy. Anyone wishing to obtain a college degree based on credits obtained from an e-learning process would encounter great difficulties for recognition. Even today, e-learning experiences alone with credits still face challenges as legitimate credits compared with those obtained from a classroom environment. Attempts to replace physical classroom experiences such as MOOCs are still struggling to legitimize themselves academically.

With the advancement in technology and its resultant educational technology applications and their access, the long-held belief in college degree obtainment through the brick and mortar channel of colleges is now witnessing emerging innovative ways of alternatives, hence one major contribution from blended learning for college degree obtainment.

At present, and probably for the foreseen future, the brick and mortar channel of colleges will continue to be dominant as an input-based approach to college degree obtainment. Prior learning experiences being an output-based process will gradually gain more acceptance, especially at more applied institutions of higher education as a more economical and innovative alternative channel for granting academic degrees (perhaps in more technological areas of studies).

The second area in higher education where blended learning is perceived as destructive is curriculum composition in that a traditionally acceptable (recognizable) major can now make up with courses from more than one area of studies. Such quasi-majors, often characterized as interdisciplinary (or blended programs), allow students to undertake two areas of studies as their declared major (unlike a double or dual major arrangement where students are expected to fulfill required course load expectations from both majors).

Some experimental curriculum design is now being experimented in some U.S. colleges (for instance, the CS+X set-up offered at Stanford University). Blending the curriculum composition for a college degree could be expected to be a promising trend in meeting the needs of students as well as expectations of future employers who wish to see college graduates educated in a wider range of academic areas and prepared for a work environment that expects multi-facet repertoire of competencies.

Educational delivery for the teaching and learning processes is probably the most noticeable area in higher education where blended learning manifests its destructive power in that delivery in teaching being shared between the instructor and the students is gaining more consensus in most U.S. colleges, and some in China. Pedagogical practices under blended learning concept challenge faculty members who are used to a more teaching-centered belief. It is a more daunting task to change their teaching behavior for those whose cultural beliefs favor a teacher-dominance in the classroom. College instructors are expected to be able to blend their pedagogical practices with a variety of teaching methods to better fit the learning situations, hence a more blended teaching and learning process now than before.

To facilitate the transition from a teaching-dominance to learning-centrality concept, faculty development provides a valuable and vital opportunity for faculty members to equip themselves for the blended pedagogical expectations. In addition, classroom facilities have also seen changes of the ancillaries to support blended learning (e.g., smart classrooms, use of more user friendly tech-gadgets). In this transformation for the teaching process and the instructors, the learning process and students are also engaged in this blended learning revolution. More student engagement is perhaps a good term to describe such endeavor where students learning outcomes predetermine that their learning processes and deliverables characterize what blended learning implies: teaching and learning is a shared responsibility, rather than a clean division of labor between the instructor and students.

Once higher education expects such shared responsibility from both parties involved, blended learning will continue to be a challenge for those who are to join the higher education academy from an environment (students from K-12, for instance) where blended learning is still less popular.

The class evaluation as being the benchmark for determining college degree completion still remains the sole basis. However, stakeholders and other constituents from the larger society have challenged this basis for college outcomes evaluation. For instance, public accountability for public educational institutions, accreditors (in the U.S. and a number of other countries, for instance) for educational entities, feedback from employers, and the academia themselves have all made the cries over the trustworthiness of evaluation information concerning quality in education. With this cry for more evidence for quality for educational programs, their delivery, and their outcomes, the adoption of blended learning inevitably becomes destructive to education evaluation. For instance, the evaluation of student learning outcomes is expected to take into consideration the teaching input design and delivery processes. Assessment design is expected to align with a blended combination of intended learning goals as well.

With the many changes taking place in higher education, assessment of student learning outcomes could be described as the most significant change, featuring a strong blenededness in assessment design, methodologies, and types of assessment data for evidence. A major driver is from the attempt to answer increasing public accountability issues as well as reflection by the academia themselves on own practices for quality assurances.

Faculty development again provides timely support for faculty members to reflect on their current assessment practices, learn and experiment with innovative methods to assess student learning through an array of methods, and produce resultant artifacts. It could also predict that blended learning once adopted for the teaching input design and teaching and learning processes will pose most practical challenges for assessment of student learning outcomes. Blended assessment might be a term to describe this foreseen future trend.

The description of what a college degree is like can be easy when seating time provides the sole platform from which student learning completion information is drawn. The same claim cannot be easily made today. A college degree as argued earlier in this paper in a blended learning environment along with societal expectations cannot be readily explained with seating time. Different attempts have been made to define today's college degree. Such definitions focus on domains of expected curriculum coverage (areas of learning), learning experiences (exposures and engagement), and learning outcomes (attributes) (National Research Council, 2001) [12]. It could be safe to say that those expected spectrum areas display a blended nature.

When blended learning would become incorporated into the curriculum, the teaching and learning processes, and the assessment of learning outcomes, then blended learning is sure to become destructive to the definition of college graduates. Those attributes reflect expectations from three major stakeholder groups: that of the society that expects graduates to be able for the employment demands, that of the educational institution that expects graduates to have possessed pre-defined attributes and capabilities, and that of the students themselves who expect to see personally defined ROI (return of investment).

4 Conclusions and Suggestions for Consideration

Convergence and divergence are two constant features in blended learning; the faster that technology invades education, the stronger the resistance from education will become against such outside impact, after an initial period of seemingly acceptance (convergence phenomenon) of such outside visiting forces. Those elements from the accepted parts of outside invaders will be merged to become integral parts within own system (convergent function). Those elements that are not accepted would be marginalized as minority of alternatives to mainstream of education.

Blended learning as a by-product of today's technology will remain one of a number of potential alternatives to the mainstream degree granting practice. As with all other existing and emerging alternatives, blended learning serves as a mover, inviting and pushing re-considerations of existing educational practices for enhancement.

Challenging this blended learning phenomenon will perhaps come from a cultural perspective [5]. Education is embedded in the culture where education matures, reflects the core values, preserves the frame within which culture evolves and functions. Hofstede's notion [6, 7] of national cultures provides one powerful platform to understand how acceptable blended learning would be like from a cultural dimension perspective. A culture-based acceptance and practice for blended learning might explain why blended learning could be easily adopted and successful in one educational system than in another.

With a culture that favors stability, Chinese educational system tends to seek stability and manageability. Such cultural perspective might help predict that blended learning might be accepted with more challenges in Chinese higher education system than in the U.S. higher education system, as pointed by Kahneman that "in general, loss aversion favors stability over change" [9]. The acceptance would be greatly facilitated with more push for internationalization in higher education; however, the pace would be relatively slow and the number of institutions to adopt blended learning would be small.

This paper would conclude with the following suggested approaches to blended learning for consideration.

The first suggested approach is blended learning with pedagogy. The integration between the two can help endorse to supplement instructional delivery for more student engagement in the teaching and learning processes. Students' rich know-how of technology can be effectively utilized, while instructors are motivated to infuse their technological capabilities in their teaching processes.

The use of technology-enabled gadgets and Apps to broaden and create a variety of learning opportunities should aim to enhance college experiences as well as learning outcomes. Through the utilization of such tech-platforms, more and authentic student interactivities in their learning could be empowered, hence, more student engagement.

The second suggested approach is blended learning with evaluation. Blended learning should be embedded in evaluating quality of students' learning as a supplement to the use of blended learning with pedagogy. Such an alignment between the two approaches to pedagogy and evaluation can reinforce the connectedness between the teaching and learning processes along with their outcomes. Evaluation of learning outcomes from a blended learning environment would serve as a positive recognition of the pedagogical blendedness.

The third approach suggested is with the expectation of college graduate attributes where the inclusion and articulation of graduate attributes should blend traditionally held academic capabilities and current expected societal capabilities. In this sense, blended learning becomes a platform that blends the learned academy and the society at large. College learning under such blendedness is more society conscious in what constitutes core elements in a college degree.

As an addendum to the three suggestions is a caution for the scale of adopting blended learning in the three aspects of higher education in China. This caution is two-fold:

a small number, rather than a large number, of institutions of higher education could be the fore-front adopters, and the adoption should be at a slower pace, rather than at a fast pace. Successful and smooth adoption of blended learning expects colleges to be conceptually and implementationally ready, which is the case for only a small number of institutions at present. The majority would fare better and more responsibly without adopting blended learning, or partially adopting blended learning, say, in re-articulating college graduate attributes. A slower pace of adoption of blended learning, on the other hand, would ensure effective and smooth adoption in terms of developing a comfort level by both institutions and students. Piloting and evaluating the adoption of blended learning in pedagogy, for instance, before pushing such adoption in all domains of curriculum design, pedagogy, and evaluation would leave room for reflection and better integration.

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The Blended Learning Concept: Comparative Study of Two Universities

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Abstract. The paper introduces the results of comparative study of the blended learning concept of two higher education institutions – University of Ostrava, Faculty of education and University of Hradec Kralove, Faculty of Informatics and Management, Czech Republic. Having the research sample of 466 and 591 students of both institutions, the data collected within LMSs were processed by the method of frequency analysis, structured according three criteria (learners' visit rate to the course, learners' performance in week days and learners' performance in hours of the day) and compared. In the results different number of assignments was reflected showing higher visit rate to the Technology for education course conducted at University of Ostrava compared to English for specific purposes at University of Hradec Kralove.

Keywords: ESP · English for specific purposes · Technologies for education · Higher education · Online courses · Blended learning · Blackboard · Moodle · Visit rate · Performance · Tracking

1 Introduction

In the period of i-society and e-society the role of information and communication technologies (ICT) has been increasing in all spheres of human lives and the blended learning concept has had a rather firm position in the system of education. Within a two-decade long history of ICT enhanced instruction in the Czech Republic, two higher education institutions were the leaders in the process – University of Ostrava and University of Hradec Kralove. Despite working under different conditions, their efforts resulted in didactically identical concepts of blended learning.

Therefore, the main objective of this paper is to track learners' performance in the courses in LMS and compare two concepts of blended learning model exploited at two higher education institutions in the Czech Republic.

2 Theoretical Background

Various approaches to blended learning exploitation have been applied and different definitions have been set. The blended learning can serve different purposes, i.e. be expressed

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in various kinds of intended learning outcomes, media and approaches to teaching, as Valiathan [1] states. The final 'blend' may comprise of mixing e-learning (i.e. any type of ICT enhanced learning) and traditional classroom instruction led by the teacher), various media, theories of learning, learning objectives, and/or pedagogies, i.e. pedagogic approaches. However, the question may appear which term is correct: blended, or hybrid learning.

Heretofore, it should be stated that the terms of blended learning and hybrid learning have not been clearly and explicitly defined.

The blended learning development has gone through several phases, as Friesen [2] summarizes. In the first phase called 'Origin and divergence' (1999 – 2004) it was understood as the use of two or more distinct methods of training, blending e.g. classroom instruction and online instruction, online instruction and access to a coach or faculty member, simulations and structured courses, managerial coaching and e-learning activities etc. [3]. The second phase of 'Consolidation and clarification' (2006 – 2012) is bounded by publishing two crucial works: (1) by Bonk and Graham [4], where the blended learning is the combination of instruction from two historically separate models of teaching and learning – traditional face-to-face learning systems and distributed learning systems, and (2) by Randy Garrison and Vaughan [5], saying that blended learning is the thoughtful fusion of face-to-face and online learning experiences. In the third phase of 'Current use and elaboration' (2013 – now) the meaning of blended learning changed over time. Currently, it designates the range of possibilities presented by combining the Internet and digital media with established classroom forms that require the physical co-presence of teacher and students [2].

Thus we can conclude the term 'blended learning' has gained considerable value in recent years as a description of particular forms of teaching with technology. In our work we use one of the definitions by Whitelock and Jelfs [6] describing the blended learning as the integrated combination of traditional learning with web-based online approach, particularly supported by Discroll [7] who defined the blended learning to be the combination of various types of web-based technology to accomplish an educational goal, of various pedagogical approaches to produce an optimal learning outcome with or without instructional technology and of various forms of instructional technology with face-to-face instructor-led training.

The term of hybrid learning is either used specifically, e.g. by the University of Illinois Online Network (ION) [8], or interchangeably with the term of blended learning, e.g. by the University of Washington, Bothel [9]. ION applies the criterion of the time spent in a classroom and online and differentiates between blended and hybrid courses as follows: onground courses have all learning activities implemented in the face-to-face classroom instruction; blended courses run a significant amount of activities in face-to-face classroom settings and some materials are available online but no online instruction time is substituted for face-to-face time; in hybrid courses a significant amount of learning activities have been moved online and face-to-face classroom time is reduced but not eliminated; and in online courses all learning activities are conducted online [10]. University of Washington, Bothel [9] defines both terms as a model of course design that combines traditional, face-to-face class time with online and out-of-class course work. For UW Bothell specifically, hybrid courses are those where 25–50 % of the traditional face-to-face class time is replaced with online or out-of-class work. The share of in-class and out-of-class work differentiates hybrid (blended) courses from Web-enhanced courses, where learners continue to meet during the normal class hours and use the online component to supplement face-to-face time. In online learning 100 % of the course is conducted fully online within the LMS [11]. Similarly to Bothel, the University of Wisconsin, Milwaukee indicates that hybrid and blended mean essentially the same thing (as well as mixed), and describe the hybrid as a course where the traditional face-to face time has been replaced by online learning activities [12].

Last but not least, an interesting approach to distinguishing the difference between blended and hybrid learning was introduced by Friend [13] stating that in education, the term blended enjoys nearly exclusive use in the literature and focuses on the design and structure of the course, rather than its content, and seeks to create a path of instruction that best guides students to reach predetermined outcomes. In other, non-educational, disciplines, the term hybrid is far more common (with blended being used parenthetically just to make sure readers know what authors are talking about), rather not focusing on the course structure but helping students master the subject matter by using various delivery modes and thus allowing them to learn a different way. "The distinctions in terminology are apropos, too, consistent with other uses in society. For instance, if you have a blended drink, be it a milkshake or something perhaps a little stronger, the point of the blending is to ensure no one flavour or texture stands out, to provide a consistent experience toward a predictable goal. If you have a hybrid vehicle, the point is to use the electric motor at times when it excels (such as slow speeds and stop-and-go traffic) and the combustion engine when it excels (such as highway speeds and inclines). To be sure, a sophisticated hybrid vehicle manages the handoff from one power source to another fairly adeptly. That's a matter of good design, just like a hybrid course needs good design to feel like it fits two disparate course types together naturally." [13: 2].

3 The Blended Learning Concept and Research Design

In the concept described below the term of blended learning follows the Whitelock and Jelfs [6] approach understanding the blended learning as the integrated combination of traditional learning with web-based online approach, of media and tools employed in an e-learning environment and of a number of pedagogic approaches, irrespective of learning technology use. The concept is applied at two Czech higher education institutions – University of Ostrava (UO), Faculty of Education (FE) and University of Hradec Kralove (UHK), Faculty of Informatics and Management (FIM). Despite the institutions and students enrolled in the observed courses differ in several criteria, the blended learning concept is identical bearing following characteristics:

- All participants were part-time students of bachelor study programmes.
- Both courses started with face-to-face (F2F) tutorials held in the first week of semester; didactic recommendations were provided there to the students on how to study efficiently in the course. Then, autonomous learning in the online courses was conducted through 10 weeks. In the final week of the semester, the final F2F tutorial was held where selected topics of the learning content were discussed. Finally, when

the semester was over, learners' knowledge was evaluated in the exam period by the written credit test (in both subjects) and oral examination in ESP.

- Both courses were designed in the learning management systems (LMSs) – in Moodle for UO FE students and in Blackboard for UHK FIM students. These LMSs are primarily determined for education so appropriate tools for conducting the learning process are available to the users. In the structure of each course six tools were implemented as follows: In *Syllabus* the learning content of each course was summarized, obligatory and optional assignments displayed, teaching methods described, learning objectives introduced, required reading and additional sources listed, requirements for the credit/exam test and its form described. *Study materials* were structured into chapters; each chapter was devoted to one topic. Although the number of chapters was different in each course, a total quantity of learning content was comparable. The learning content in individual courses was scheduled for 12 weeks (i.e. 1 + 10 + 1 weeks). The Introductory chapter was again included in each course providing a brief summary of instructions on how to study efficiently as presented in Syllabus. Learners' knowledge was *tested* by various types of tests; multiple-choice tests with one or more correct answers were largely used, as well as dichotomous of Yes/No and True/False types and the open-answer tasks. Jumbled sentences, fill-in-gaps, translations, which are suitable for testing foreign language skills, were applied in the ESP course only. *Assignments* were planned as learners' independent homework on a topic going deep into the learning content acquired in the course. Two long assignments of essay type were required in ESP course, and 10 short assignments (one per week) were included in Technology for education course. The *Discussion* tool and e-mail service enabled teacher – student and teacher – students' communication, either of private, or public type.

Table 1. Research sample: characteristics.

	UO FE	UHK FIM
Students (n)	466	591
Study programmes	Pre-service teachers, pedagogy, pedagogy of handicapped people	Applied informatics, information management
LMS	Moodle	Blackboard
Subject	Technology for education	English for specific purposes
Level	Bachelor	
Form	Part-time	
Blended learning	F2F starting tutorial, autonomous learning, F2F final tutorial	

However, the research groups differ in:

- Study programmes: at UO FE the research sample consisted of pre-service teachers, students of Pedagogy and Pedagogy of handicapped people; at UHK FIM students of Applied Informatics and Information Management were included.
- Amount of participating students (UO FE: n = 466; UHK FIM: n = 591).

- Subject studied in the online course: at UO FE the course focused on Technology for education (TE); at UHK FIM the course of English for specific purposes (ESP) was researched.

Main characteristics of the research sample are summarized in Table 1.

Students' all semester performance in both online courses in the LMSs was tracked. To sum up,

- the Course Content of both courses followed the same structure, i.e. Syllabus, Study Materials (SM), Tests, Assignments, Communication tools (Discussions, E-mail) were available to the students;
- the instructional design mentioned above, i.e. starting tutorial in the first week of semester, autonomous learning for 10 weeks and final tutorial in the 12th week of semester, was also identical in both courses;
- having assumed these two features coincident, the whole concept of blended learning could be considered identical.

In the research the method of tracking student' performance in the course was applied, monitoring particularly amounts (frequency) of hits to single tools. The data were collected automatically through the LMS services. Following three characteristics were tracked:

- learners' visit rate to the course;
- learners' performance on weekdays;
- learners' performance in daytime.

The criterion of time spent in the course was not considered because students often login to the course but do not really work there.

4 Research Results

The collected data were processed by the method of frequency analysis by the NCSS2007 statistical software. Results are presented in tables and figures, described and discussed.

4.1 Learners' Visit Rate to the Courses

Totally, 6,072 hits were detected in the ESP course (n = 591), which is 1.8 per student, and 6,320 hits in TE course (n = 466), which makes 2.7 hits per students. This result clearly shows students in the TE course accessed their course more frequently. As displayed in Table 2 and Fig. 1, the visit rates to Syllabus, Study materials and Tests were rather similar. Strong differences were detected in Assignments and, consequently, in the use of Discussion tool. The reason is in the difference in numbers of assignments. As mentioned above, two long assignments of essay type were required in ESP course in weeks five and ten, and 10 short assignments (one per week) were included in Technology for education course. Thus the UO FE students had higher visit rate to Assignments (1,584) compared to FIM UHK (699), and logically, they conducted more discussions on how to make the assignments and the visit rate to the discussion tool was higher (1,631 with UO FE students compared to 1,375 hits with FIM UHK).

Table 2. ESP versus TE: Hits to single tools – hits per student, total amount of hits (n) (authors' own source).

	ESP: hits/student	ESP: hits total	TE: hits/student	TE: hits total
Syllabus	1.275	753	1.430	666
Study materials	2.825	1,669	2.726	1,215
Tests	2.667	1,576	2.628	1,224
Assignments	1.183	699	3.400	1,584
Discussion	2.328	1,375	3.500	1,631
Total		6,072		6,320
Mean	1.828		2.736	

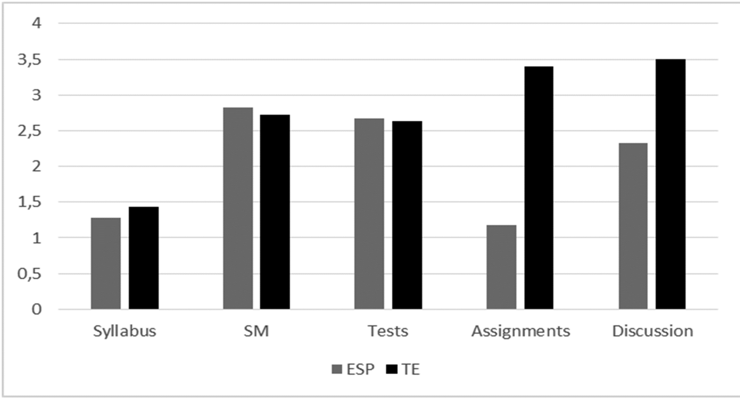

Fig. 1. ESP versus TE: amounts of hits to single tools per student (n) (authors' own source).

4.2 Learners' Performance on Weekdays

Learners' visit rate in single weekdays during the 10-week long period of autonomous learning in courses differs substantially. The total amount of hits was three times higher in TE course. This result definitely correlates to activities relating to making assignments and discussion them, as mentioned in 4.1. Whereas the curve sharply reaches the highest peak on Wednesdays in ESP course, TE students were most active on Fridays; the lowest visit rate was detected after Wednesdays, i.e. from Fridays to Sundays in ESP course. However, TE students are least active after hard work on Fridays, i.e. on Saturdays but their activity rises at the end of weeks. The complete results are displayed in Table 3 and Fig. 2.

Table 3. ESP versus TE: hits to single tools – hits per student in single days during 10 weeks (n) (authors' own source).

	ESP	TE
Monday	17	53
Tuesday	14	44
Wednesday	31	58
Thursday	12	61
Friday	16	64
Saturday	13	40
Sunday	11	48
Total	**113**	**368**

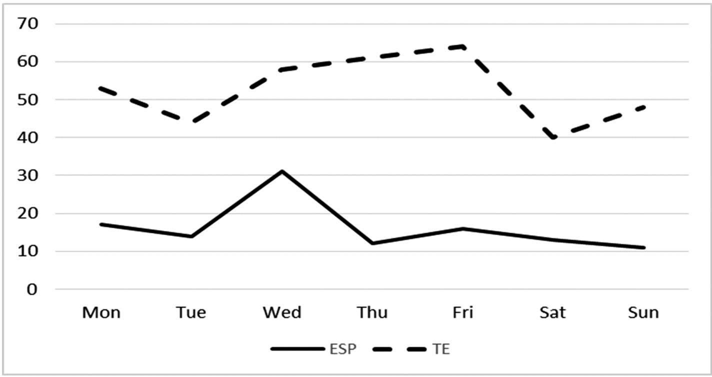

Fig. 2. ESP versus TE: hits to single tools – hits per student in single days during 10 weeks (n) (authors' own source).

4.3 Learners' Performance in Daytime

Figures 3 and 4 show learners' performance in daytime. In ESP course two peak time times were detected: 8 p.m. and 11 a.m., each of them having approximately a two-hour increase in study activity before the peak and two-hour period after it. Between the peak times a rather active period was detected from 2 p.m. to 5 p.m. Several students made hits late nights, probably in the time close to the examination period, and/or students of Informatics in ESP course sometimes prefer working late night. As expected, no activity appeared late-night/early-morning hours, i.e. from 2 a.m. to 7 a.m. As for the time management and productivity of the learning process, this period is of very low efficiency [14, 15].

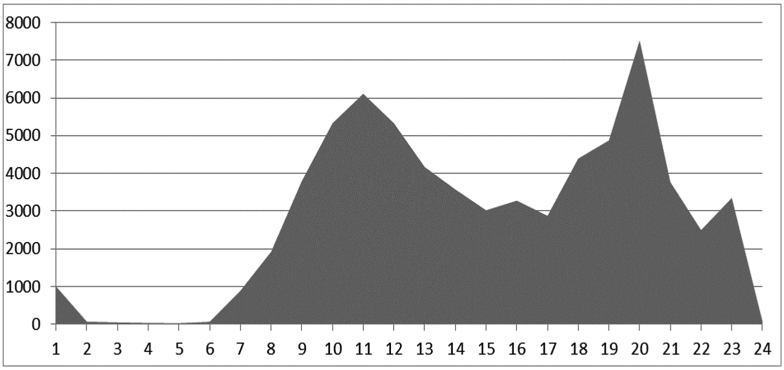

Fig. 3. ESP: learners' performance per hour of the day (n) (authors' own source).

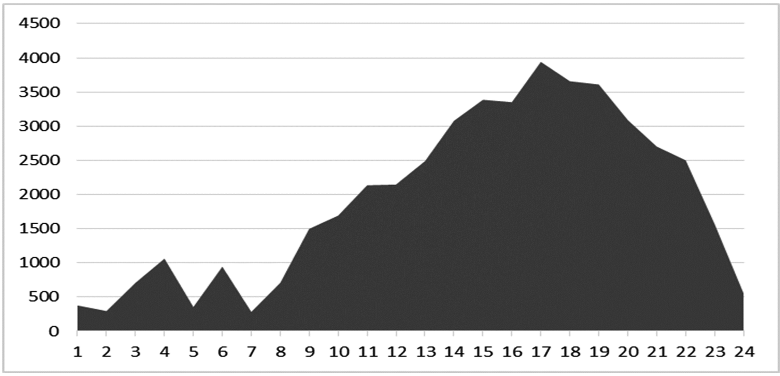

Fig. 4. TE: learners' performance per hour of the day (n) (authors' own source).

However, data were rather different in TE course. First, some, despite low, activity was detected during all day long. Second, the visit rate was lower in TE course – the higher activity reached approximately half visit rate compared to ESP course. And, third, not two peaks per day as in ESP course, but one steadily increasing peak was performed in TE. The complete results are displayed in Figs. 3 and 4.

5 Conclusion

As it can be seen from the comparison of the ESP and TE courses design, identical tools were available to the course designers and implemented in both courses. Students exploited those tools which were relevant to learning content they were going to acquire [16].

Although the subject and the research sample of the courses were different, the exploited concept of blended learning was identical. Whereas the visit rates to Syllabus, Study materials and Tests were of similar frequency, the difference was discovered in the visit rate to Assignments and Discussion tools. This difference resulted from the difference in numbers of assignments in the courses (i.e. two long assignments of essay type in ESP course and 10 short assignments in Technology for education course). Therefore, they do not relate to non-appropriateness of the concept which is not expected to be changed.

Particularly the online component enables learners to study independently on location and time, which is rather important characteristics in current times of mobile devices used anytime anywhere. Interestingly, the part-time FIM students prefer to study on weekends but Wednesdays since they probably want to spend weekends with their families. The blended form of instruction can make such a study possible and students then can display greater engagement when they are exposed to such an instruction which is much more relevant to their learning preferences [17].

The introduced blended learning concept was trying to reflect both latest trends in ICT-enhanced education and efficient pedagogies, particularly exploiting the popularity of ICT which are widely and naturally used among young people – members of net generation of 'digital natives', as Prensky called them 15 years ago [18].

In the field of ICT-enhanced ESP Bielousova [19], when speaking about the learning content, emphasized the importance of study materials tailored to students' needs within the blended learning concept as a way how students of various specializations can be provided the appropriate content through the interactive particularly designed study materials. Compared to this, separated ESP courses were designed at FIM UHK, e.g. for IT students, Financial Management students, Tourism and Management students etc. Study materials were different in each course; however, the interactivity was implemented in all of them.

As researched by Angelopoulos et al. [20], the blended learning model was applied within the training of educators to develop their knowledge and skills in computer science, which is the field comparable to Technology for education course conducted at UO FE. As exploiting the Greek School Network, the model was piloted and appreciated by the users.

Moreover, Hoic-Bozic et al. [21], analyzed the blended learning concept within the course of Multimedia systems conducted in the LMS Moodle. This approach was highly appreciated by both the learners and experts. The authors focused on the methodology and technology exploitation in the course. When considering both criteria as applied by Croatian designers and tutors, we can state they were used in the same way as in the online courses of FIM UHK and UO TE. This fact is very encouraging to us, working as another proof contributing to positive assessment of our online courses.

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A Framework to Promote ICT in K-12 Education in Developing Countries: A Case Study in Sudan

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Abstract. Information and communication technology (ICT) plays an important role in improving education, specifically K-12 education in developing countries. Promoting ICT in education in Sudan as a developing country is one of the components of the national education policy. Sudan has launched many initiatives, aimed at implementing ICT in the education system. However, some factors hinder the development of ICT, including ICT policy, infrastructure, educational resources and teacher development, as well as curriculum and assessment. As a result, this study builds upon the global status of ICT to explore how ICT can be promoted in education, and how the experiences of other countries can support this study in formulating a framework to promote ICT in K-12 education in Sudan.

Keywords: ICT · K-12 education · Developing countries · Sudan

1 Introduction

Information and Communication Technology (ICT) can be defined as "a collection of technological gear and resources used in communication, and generate, distribute, collect and administer information" [19]. These technologies include computers, Internet, radio, television, smart phones and many other tools for communication [21]. Recently, ICT has become embedded in education, to create social and economic development by assisting the educational systems to raise the quality of education. ICT plays a vital role not just in K-12 education but in education as a whole, supporting teaching and learning process, beside curricula. This role for ICT in education is increasing in importance and becoming more extended by innovations with more features of educational practice involving ICT.

The application of ICT in education in developing countries might be critical to coping with rapid progress made in developed countries. This goes in line with the viewpoint of a significant statement of United Nation Center for Science and

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Technology for Development (UNCSTD), that most developing countries have neither the infrastructure nor the human resources necessary to fully exploit the potentials of ICTs [14]. However, using ICT is an orientation for education to lead the development goals. Hence, schools need to use ICT to achieve several goals like enhance teaching and learning process, and other goals, develop student skills, and disseminate materials for teachers and students [1]. Most developing countries integrated ICT in all basic education grades of their curricula, with a focus on mathematics, social and natural sciences. Sudan as a developing country faces a lack of ICT implementation, infrastructure, learning resources, and capacity building [15]. Accordingly, promoting ICT in K-12 education is important to make tangible progress in the educational system. The country has applied ICT as a tool to integrate its economy into the global market since 2002 [8].

The successful implementation of ICT in education crucially depends on five factors that affect the application of ICT; these factors are ICT policy, infrastructure, educational resources, teacher professional development as well as curriculum and assessment [20]. This study is an attempt to help educational leaders, practitioners, and stakeholders to effectively support promoting ICT in K-12 education in Sudan, and at the same time envisage applying the declarations of UNESCO - Qingdao and Incheon of 2015. Besides helping Sudan to overcome the difficulties in the above mentioned factors, this Study aims at formulating a framework that may enable the country to harness the available potential in developing its K-12 education.

The significance of this study can be derived from the lack of several basic requirements for ICT in developing countries, and the status of Sudan as developing country trying to enhance education. This study shows the experiences of different countries as a framework to come up with a vision for Sudan. In further detail, the study addresses, the current status of ICT in the US, Europe, Asia, and Africa, in addition to the UNESCO goals for ICT in education, to explore how ICT can be promoted, and how the experiences of all these countries as well as relevant documents from the federal ministry of general education in Sudan can support this study to create a new framework for promoting ICT in K-12 education in Sudan.

2 Global Situation of ICT in K-12 Education

In this section, the study presents ICT policy, infrastructure, educational resources, and also teacher professional development, as well as curriculum and assessment, as the relevant factors regarding the implementation of ICT in education in different countries in the world [20]. It shall furthermore point out how these countries promote education according to these factors, and finally figure out the status of ICT in Sudanese K-12 education based on the experience of these countries.

2.1 Policies for ICT in Education

One of the factors is policy, which is of decisive importance in education, and the question how different countries have formulated policies to apply ICT in their educational systems. In line with UNESCO goals for ICT in education, the study seeks to determine to what extent education policy regarding ICT in Sudan is compatible with other countries. "Policy" is defined as "A course of action, adopted and pursued by a government, party, ruler, statesman, etc.; any course of action adopted as advantageous or expedient [13]. According to Om Kalthoom, establishing a policy for ICT in education "has value in itself", and that can empower schools to use new tools to support education, particularly teaching and learning, in addition to a possibility of building and sharing knowledge as well as engaging practitioners and stakeholders to help schools make more progress in using ICT [17]. Besides that, ICT can enhance educational achievement significantly, increase students' learning ability, widen access to schooling, and promote the concept of lifelong learning [11]. From this point of view, we conclude that there is a need to thoroughly plan and work toward the goals laid out by the ICT policy. The study briefly examines the situation of ICT policy in the US, UNESCO vision, the UK, Asia, and Africa in the following section.

In 1996, the US issued many policies for ICT in education within the framework of a five-year plan, as nationwide effort to prepare the students for '21st century skills'. It was designed to put the world at the fingertips of students, and later formulated into a policy to bring about a golden age in education. More recently, the plan for 2010–2020 is to make the power of technology transform American education [3] In this context, UNESCO has introduced a particular vision for ICT policy to be applied in education worldwide, and calls upon countries to develop their respective policies in support of its goals for implementation [25]. The UK has been establishing policies for an ICT national grid since 1998 following five-year plans. In Asia, China designed five-year plans since 1996 to 2020 for developing technology in education [3]. While in Africa, Kenya aimed to transform the curricula from text to digital format and facilitate the integration of ICT to deliver that content, besides improving the quality of learning by using ICT in schools, national policy was formulated in the year 2006, and embedded in the education law to improve learning outcomes in terms of literacy and numeracy at primary schools [15].

What the status of ICT in Sudan is concerned, the federal ministry of general education (FMOE) established a plan to implement ICT policy in schools across the country within five-year strategic plan (2012–2016). The policy is not simply an education policy of using ICT at schools but should be viewed in a much larger context of building e-government as a way to transform Sudan into a knowledge community, provide access to that universal knowledge community and enable Sudan to productively make use of ICT locally and nationally, and modernize the country's industry by building up ICT resources and also make connecting services available nationwide [6].

2.2 ICT Infrastructure

This section reviews the status of ICT infrastructure in various countries worldwide, to determine its status in Sudan in comparison with other countries. ICT infrastructure is about providing and maintaining educational technologies at schools [2]. These technologies and the Internet are influential factors in the teaching and learning process. The use of computers and Internet at school saw significant progress in the period of

2009–2012 [4]. In American schools, there is an abundance of computer devices and high Internet connectivity; each school has been connected to the Internet, classrooms are provided with high-speed Internet, and flexible learning space. The community also favors high Internet speed at schools, which reflects a strong contribution of communities in the practical use of ICT at schools [28]. In Europe and Asia schools have been similarly well-equipped with ICT infrastructure. At 95 % of European schools computers, laptops, and broadband, interactive whiteboards, learning management systems, and digital cameras, etc. are ubiquitous. Students can access ICT as a way to improve learning outcomes and other related competencies. Teachers and students received laptops and netbook mostly [9, 28].

In African countries, such as Kenya, Tanzania, Rwanda, and Uganda, governments began to provide schools with infrastructure and the main target to introduce technology to the schools has been to enhance the quality of education. Despite many efforts and initiatives to introduce ICT to schools, there have been different obstacles such as insufficient amounts of computers, low Internet connectivity, and a lack of educational software packages [29]. Nonetheless, Sudan has distributed an amount of 21,860 computers to secondary schools by the end of 2014. Out of 21,235 schools, 92 schools were connected to the Internet and established 103 digital classrooms, while the number of students was 1,429,258 [7, 5]. The number of computers relative to the number of students suggests a lack of equity in the access and use of computers among students. As a result, students need to be provided more opportunities to become digitally literate.

2.3 Educational Resource

As it is known, education cannot take place in the school or outside school without resources. This section of the study introduces digital learning resources, and how different countries design and install efficient learning resources to improve their education [28]. UNESCO has designed e-learning tools and materials for free, to provide assistance for teachers not just in the teaching and learning process, but also for students and learners as a whole [27]. The US established of K-12 online learning and blended learning by using digital content and virtual schools. They extensively use digital content in addition to open learning resources [26]. Similarly, in Europe, educational ministries have established databases for schools and provided a possibility to access and update these databases. Schools are provided with interactive whiteboards, and learning platforms to work as tools for facilitate the teaching and learning process. Environments of online learning are also within the scope. Multimedia also was used by teachers to enrich and optimize the teaching and learning process and enhance teaching skills [9].

Meanwhile, high quality technology equipment has been introduced in Asia (Singapore, Japan, Korea, and China), where schools have been provided with advanced computer devices, and educational platforms as well as high speed internet, a variety of digital learning resources, and information terminals for students [10]. African countries including Kenya, Tanzania, and Rwanda, on the other hand have achieved notable progress in the application of ICT in education based on the global mainstream in using digital learning resources. They equipped schools with ICT which are provided for administration and teaching use, including office package, word processing, data processing and students database in addition to sharing the resources among schools [15, 18]. In Sudan, however, the literature review suggests an absence of using digital learning resources in schools due to a lack of ICT equipment and insufficient technical support. Nevertheless, there are some students who have their own PCs and Internet access; they may access online learning resources to improve their understanding and gain more knowledge than their peers [6].

2.4 Teacher Professional Development

Teachers' professional development is one of the main factors affecting the use of ICT in education [20]. Therefore, this section shows the experience of teacher professional development in different countries to define the status of teacher development in Sudan. The importance of teacher professional development is to enable students to acquire learning skills, suitable knowledge, and useful ways of educational application. In the US, teacher development focuses on skills and competences in ICT with regard to the importance of standards to prepare teachers in meaningful ways of using technology in the classroom. In Europe, the application of ICT for improving teacher competencies is one of the main reasons to promote and exploit the potential of ICT for education. Some frameworks and models were developed and consisted of competencies enabling teachers to integrate ICT into classroom teaching and improve students' skills. The frameworks of competencies consist of categories of competencies, each category is divided into sub-competencies, and teachers have to be proficient in these competencies [23].

In Asian countries such as Singapore, Japan, and China, professional development for teachers has been a focus in the development of ICT at schools. A philosophy of "Thinking Schools, Learning Nation" focuses on offering a broad professional development for all teachers on all levels and for all contents, not just K-12 [12]. In Africa, Kenya, Tanzania, Uganda, and Rwanda designed ICT competence frameworks for teachers as a requirement to address the needs of 21st century and develop education in line with the UNESCO Competency Framework for Teachers (ICT-CFT). Professional development of teachers is important for a vision to integrate technology, involve stakeholders to support effectively applying ICT in teachers' development, models and framework, particularly Technological Pedagogical Content Knowledge (TPACK), technology integration planning model, addition to standards and suitable policies are required [18, 27]. In conclusion, countries worldwide have increased professional development of teachers in ICT, using models and frameworks of competencies like ICT-CFT for UNESCO.

2.5 Curriculum and Assessment

Curriculum and assessment are considered a cornerstone of ICT in education. It plays a pivotal role in supporting the implementation of ICT in schools. And schools need an ICT vision to support the application of this curriculum [27]. In addition, this curriculum has certain requirements; according to Tondeur those requirements constitute a framework for ICT competencies assumed to be approved by the given country's ministry of education [22]. Such a framework includes several skills for learners to gain knowledge and develop some attitudes. UNESCO has put forward a vision for introducing comprehensive ICT curricula formulating goals, learning contents. All stakeholders are encouraged to view ICT literacy as a basic learning need of any student [22]. In the US, the policy focus lies in using the power of technology in both curriculum and assessment to improve overall education quality [26].

Teachers need to measure learning outcomes to inform students, school leaders, and parents of the results of student learning. These results may well be indicative of a schools' needs, whether these needs are technological, related to teaching materials, or other educational resources. In Europe, school communities have been involved in local education planning with regard to technology and the goals that they want their schools to achieve, hence, are based on this participation of the community. ICT curricula have been designed accordingly, and schools are supplied with guidelines to use ICT in teaching and administration [9]. In terms of assessment the guidelines include providing students quality access to ICT, matching between educational goals and using ICT in schools, considering declarations of UNESCO in terms of lifelong learning, and implementing ICT within the educational planning of individual schools. Important factors such as teachers' skills, access to suitable infrastructure, learning resources, digital content, are addressed in their function to support schools' ICT curricula.

In Asia, China introduced an inclusive plan to improve education, by introducing technology in education. They developed a national framework for curriculum for grades 1 to 9, and another framework for grades 9-12, in addition to formulating national standards for educational technology [28]. In Africa, countries aspire to utilize the power of ICT to implement changes in education. Such changes could be realized by using ICT as pedagogical gadgets facilitating the learning process, based upon Internet access and other services that teachers may use. The desired goals in pedagogy are perceived in terms of ICT literacy and in moving away from viewing ICT as just a set of supporting tools to ICT playing a major role in curriculum and teacher as well as student development [16]. In conclusion, the review of ICT developments and strategies in various countries and regions around the world points to two approaches: The first is to formulate policy for curriculum-based ICT; the second is to attach significance to and prioritize ICT in the educational process.

3 A Framework to Promote ICT in K-12 Education in Sudan

Based on the experiences of the countries mentioned above, the authors believe that addressing the same factors stated by Tay, may introduce a perspective for Sudan to promote ICT in K-12 education [20], for which the author proposes a framework. The proposed framework includes three steps, namely: inputs, promoting process and outputs; the inputs of the model include five factors as follows: ICT policy, infrastructure, educational resources, teacher professional development as well as curriculum and assessment. The promoting process is a mechanism to combine the five factors of input step to produce quality of education as an output of the framework.

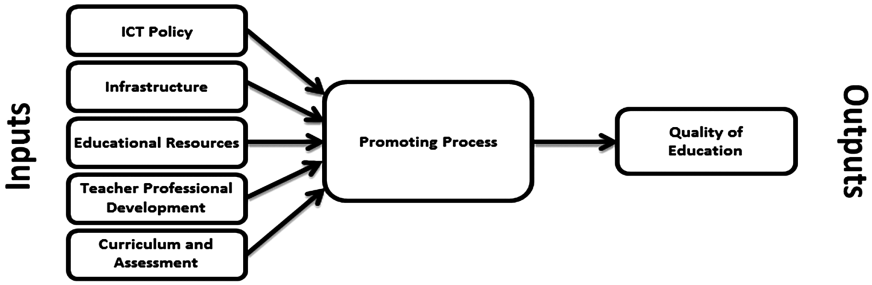

Fig. 1. Shows the framework to promoting ICT in K-12 education in Sudan. The framework consists of five, factors in the inputs steps these factors interact in the promoting process to give the quality of education as outputs of the framework (model by authors).

3.1 ICT Policy

Educational planners in Sudan might need to increase their awareness of the fact that economic and social development cannot be separated from educational development, and education cannot progress without an ambitious policy. Hence, ICT policy is one of the important factors to promote ICT in the country's education system. To achieve a high quality of education Sudan should make effective use of ICT in education by formulating a comprehensive policy in line with the UNESCO Qingdao and Incheon declarations of 2015 and benefit from other countries' experiences.

The federal ministry of general education as main body to oversee K-12 education in Sudan should formulate a vision for an ICT policy plan as a five- or ten-year plan- to guide the implementation of ICT in schools, to help the administrators promote a culture of ICT in schools, to establish schools' data bases, and to provide overall assistance to teachers and students in the teaching and learning process. Policy makers and education planners should consider the declarations of UNESCO and experiences of different countries to make policies adapt to the fast pace of introducing technology in education. Additionally, they need to consider establishing master plans to support the attainment of educational goals, the transformation of knowledge transmission, and the development of pedagogy for innovation. Involving different stakeholders in the process of policy design might enable communities to build partnerships with schools and play helpful a role in capacity building and that may help Sudan create sustainable development in education, as well as economy and society at large.

3.2 Infrastructure

Infrastructure can be defined as ICT network and computer that can be used at schools as well as any other related component [22]. Based on the studies conducted in Sudan, there is a need for ICT infrastructure to help create an educational environment for effective educational outcomes. The federal ministry of general education could focus on the following points: Reducing the computer per student ratio by providing enough computers for the schools in classrooms and particularly computer labs, enabling high speed internet access to foster the educational process and making ICT available to the school community, offering digital devices such as laptop computers, interactive whiteboards, projectors, digital cameras, notebooks, tablets, etc. and educational software programs like drill, tutorial, games, hypermedia, etc., besides e-library in the school to be as learning repository for educational material which is to be provided by the ministry of education, school database, and from educational websites toward the smart school.

3.3 Educational ICT Resources

Educational ICT resources have been defined as 'hypermedia', and other instruments such as software that support educators, teachers and students to perform their educational tasks [12]. The authors believe that the importance of educational ICT resources lies in helping teachers design tasks and activities for students, provide them with feedback, and interact with them in an effort to foster collaboration skills. The framework of this study introduces educational ICT resources as a way to support effective teaching and learning as well as design innovations to acquire 21st century skills. Educational ICT resources can be used more effectively in Sudanese K-12 education if schools establish online platforms and school databases to share resources and transform schools into knowledge communities.

School administrators not only function as local decision makers but also play a consultative role in providing orientation and encouraging teachers and students to achieve basic ICT literacy or even skills in more advanced applications. This all can help countries and communities improve education outcomes. It is of vital importance for K-12 schools in Sudan to build digital learning resources, such as open educational resources (OER). Social media use is widespread among students, especially in urban areas of Sudan. Building up on these existing resources, the FMOE could envisage ways to utilize social networks as learning resources. The global context of this study has shown that digital learning resources are indispensable in developing K-12 education in Sudan.

3.4 Professional Development of ICT Talents

This additional factor in teacher professional development is an important issue for ICT talents. The professional development of ICT talents includes (information literacy, media literacy, and digital literacy), standards for ICT competencies in teachers in administrators as well as students. Teacher professional development is an essential factor to develop education as a whole; when teachers are trained in a professional and advanced way they will acquire the knowledge and skills that have the power to bring out the best in their students, develop their creative potential and enable them to better cope with future challenges.

However, teacher professional development in ICT should be based on a framework of competencies, based on national ICT standards for teacher development. Besides this, teachers have to play a more proactive role by harnessing the potentials of software applications to realize best practice in the classroom and develop the students' digital skills; to introduce modern content and enable innovative practice. Furthermore, the ministry of education could team up with universities in the countryside to implement the national standards for teachers' and students' competencies in the teacher training programs. Viewed in a global context, countries seek to achieve their comprehensive development through effective use of ICT in education. Sudan could follow suit to fuel its educational development and at the same time promote national stability, economic and social development.

3.5 ICT Utilization

Utilization of ICT includes the teaching utilization, administrative utilization and department for ICT to support curriculum and assessment development. It is important to deliver the ICT curriculum to develop student skills that are not addressed in previous curricula, to keep up with using ICT in education. This point shows the importance of implementation of ICT in the K-12 curriculum of Sudan, in addition to measuring integration of ICT in education and how that can improve the teaching and learning process. The assessment of educational outcomes requires a scale that should be designed by FMOE, including standards for assessment.

3.6 Industries of ICT

The role of these industries is to provide the digital devices like desktop computers, laptops, netbooks, tablet computers, smartphones, Internet access tools and also additional equipment (e.g. interactive whiteboards, learning management systems, digital cameras, etc.), alongside software programs, national broadband network, maintenance, and centers for computer training. It should be a priority to provide the countryside with internet services and enable each state to provide schools with services and equip them with ICT instruments. Realizing this step might help the country to meet the requirements of educational development and reduce the cost of technological equipment for schools. In this way, a modernized digital infrastructure could turn the conventional learning space into a digital learning space, and this vision could drive the effective application of ICT in schools toward a higher quality of education, as the framework of this study puts forward.

4 The Promoting Process in Sudan

The promoting process consists of a six-step cycle to complete the promoting process. These steps are ICT Utilization, ICT Policy and Vision, Infrastructure, Industries, Educational Resources and ICT Talents. These factors interact as follows: in a first step, the study addressed ICT policies in different countries to figure out how ICT could promote educational development. Consequently, the role of this policy can be assumed to guide the implementation process of ICT in schools. The promoting process is furthermore requiring suitable infrastructure, and that may depend on the extent to which this infrastructure has been established. Well-designed infrastructure might assist schools to make well progress by support teachers to apply technology in the classroom. Similarly, the availability of digital learning resources could enable teachers to keep up with the educational progress in their fields and support them with new information, new applications and theories.

Such progress might facilitate the development of a teacher's digital competencies, skills, attitudes, and knowledge. Nevertheless, the delivery of knowledge and development of students' skills should be based on the ICT curriculum and assessment methods as decreed by the federal ministry of general education, with adjust the application of ICT in schools, and achieve the ultimate goal of quality of education. ICT talents, in the sense of computer literate teachers and other staff should be subject to national standards for teachers, administrators and students. Their competent interaction can make the application of ICT in schools more effective.

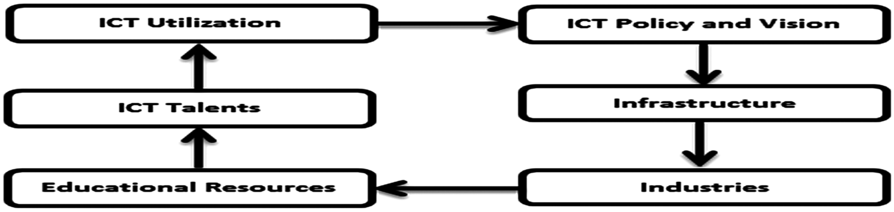

Fig. 2. Promoting Process of ICT in K-12 Education in Sudan. This graph shows a cycle consisting of six steps to promote ICT. These steps work together to achieve a higher quality of education which can be realized by using ICT in K-12 education (model by authors).

5 Conclusion

The study shows that ICT could support Sudan as a developing country that faces a lack of infrastructure and other significant factors, such as teacher professional development as a driving force of knowledge transmission. Efforts are needed to improve educational resources with regard to teaching and learning and administrator use, in addition to a comprehensive policy for ICT implementation in K-12 education, also primary and not merely secondary. These issues are the main challenges hindering the implementation of ICT in education in Sudan. Furthermore, this study has shown how Sudan may overcome these obstacles to make significant progress in K-12 education and achieve high-quality education. The global situation of ICT in different countries shows some limitations in the implementation of the policy in the primary schools in Sudan. The country's existing infrastructure cannot match that of the countries addressed in the study. Schools still use textbooks and blackboards as main educational resources, and there have been no interactive whiteboards, no digital classroom, etc. The global context of this study has shown that digital learning resources are indispensable to develop K-12 education in Sudan and teachers' professional development needs to focus on the ICT framework and standards to develop teachers' digital competencies.

A policy of ICT curriculum needs to focus on ICT literacy as required competencies to achieve the necessary changes. Such a curriculum is to enhance the teaching and learning process, and implement ICT in schools, planning to use ICT effectively and monitoring and evaluating the learning outcomes. At the school level, creating awareness of ICT in the teaching and learning process may make teachers more likely to use software programs assumed to be offered by schools, besides online learning platforms to enable online interaction between teachers and students firstly, and among students or peers secondly.

The other important point which can help schools to get more support is to engage the local community in the schools issues. Such engagement can contribute to creating opportunities for the schools: The first opportunity is to support the schools management; the second opportunity is to offer some devices and instruments for infrastructure development; the third opportunity is to enable coordination with telecommunication companies to provide broadband service for schools in Sudan to have their own websites and databases on the Internet; the fourth opportunity is to find more ways of using digital learning resources; the fifth opportunity is to reform the learning environment of schools and make it as open as possible. In these ways, schools can improve the learning space to be compatible with global learning spaces. The local ministries of education in the states of Sudan can cooperate with universities in these states to train teachers, to support the schools technologically, as well as to offer some training opportunities for school administrators.

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Practice and Prospect Analysis of Blended Learning in Primary and Middle Schools in China

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Abstract. This paper describes the background of blended learning in primary and middle schools in China, discusses the meaning of blended learning, differentiates blended learning from hybrid learning, and points out that only combinations of technology, content and way of learning characterized as high output through instructional design could stand out in practice. This paper summarizes and analyzes the three modes of blended learning reaching maturity in primary and middle schools in China through the viewpoint of how digital media and internet technology interact with teaching and learning processes, and through further analyses of the relations among teachers, students and learning contents, this paper explains the difference between the major responsibilities of the teacher and the student in blended learning and that in face-to-face instruction. The author holds that blended learning requires more support from educational environment and resources than that of face to face instruction; thus, knowledge, experience and professional capability of the teacher need to be further improved. These are the foundation of the development of blended learning in practice. With the plan and advancement of the Chinese government, blended learning in primary and middle school will be the new normal and transform to hybrid learning step by step.

Keywords: Blended learning · ICT in education · Teacher · Student · Learning content

1 Background

Blended learning is an existing concept. There are authors who conducted retrieval analysis to thesis including relevant concepts of blended learning, including blend* learning, flexible learning, hybrid learning, etc. in Web of Science database (developed by Thomson Scientific) and found that: blended learning is in the gloom during 2003–2007 in the whole globe, while starting from 2007, it began to regain increasing attention. The wave reached its peak at 2012, with study on blended learning receiving extensive attention, academic exchanges growing and study outputs flourishing [8].

Scholars at home and abroad both believe that: the revival of blended learning is directly linked to the development of online learning, and to be specific, it is revived from the reflection of the limitation of online learning changing face-to-face instruction.

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One of its key features is the blending of face-to-face instruction and online learning. Professor He Kekang is one of the scholars who introduced and promoted blended learning in China in the early years. He pointed out that the international circle of educational technology, while summarizing experience from web education over the nearest decade, endowed blended learning with a whole new understanding. He believes that the so called blended learning is to combine the advantage of the traditional learning mode and the advantage of E-learning, and that is to say, the leading effect of teachers in guiding, inspiring and monitoring needs to be unleashed, as well as the activity, positivity, and creativity of students as the subject of the learning process needs to be fully displayed. The new meaning of blended learning tells that the revival of this concept not only mirrors the change of how the international circle of educational technology regards learning mode, but also a huge progress of its cognition on educational theories and instructional ideas. The change may seem as regression and reminiscence at first sight, but in fact it follows a spiral escalation, and indicates that understanding on education is deepening, theory on educational technology is advancing and thoughts and ideas of the international circle of educational technology is experiencing a historical change [2].

In 2012, the Chinese government proposed and promoted ICT construction and application featuring "Connecting schools through broadband network, connecting classes with quality educational resources and connecting students with cyber learning space" [4], and as a result, cyber learning environment in primary and middle schools improved rapidly in most areas. The National Steering and Assessing Report on ICT in Education shows: the goal of "connecting schools with broadband network" is achieved. By November, 2014, schools (teaching site not included) accessing internet reached 82 %, with 32 % schools enjoy a bandwidth of 4 M–10 M, and 41 % schools enjoy a bandwidth exceeding 10 M. Primary and Middle schools equipped with multi-media teaching facilities reached 78 %, within which, all classrooms equipped with multi-media teaching facilities reached 39 % and half classrooms equipped with multi-media teaching facilities reached 46 %. "Connecting classrooms with quality educational resources" has seen initial success. Different provinces adopted different measures, and together they pushed forward the application of quality educational resources in teaching and learning steadily and thus promoted the sharing of quality educational resources with rural, remote, poverty-stricken and minority areas. Nowadays, teachers using quality digital educational resources to prepare and conduct the lesson has become a new normal [6]. In 2013, the Notice on Embarking the National Training Plan (Department of Teacher Education (2013)2) co-issued by the Ministry of Education and the Ministry of Finance for the first time clearly proposed to launch blended training, change distance training mode for teachers, build online research communities to promote blended learning featuring the combination of online and offline research, and the combination of virtual learning and daily teaching practice. The aim is to build teacher learning communities and virtuous operating mechanisms of school-based research and training and thus push forward the normalization of teacher education and the independent professional development of teachers. With the change brought by ICT in education, its application is being more active than ever. Using ICT to help rural remote schools to open all required courses, improve the quality of teaching and learning and foster students' ability to analyze and solve problems have become major themes of practice for educational researchers and first-line teachers, and many blended learning modes combining face-to-face instruction to online learning have come into our view. Some of these modes have become daily practices instead of one time experimental application. Today, in the primary and middle schools of China, ideas and modes of blended learning are accepted and tried by more and more peers from the educational sphere both in teachers' professional development and daily teaching and learning.

2 Application Modes of Blended Learning

2.1 Meaning and Modes of Blended Learning

Though the academic sphere agreed on that one of the characteristics of blended learning is the combination of face-to-face instruction and online learning, many hold different opinions on its full meaning. There are lots of scholars who think the combination of traditional instruction and online learning cannot represent blended learning as a whole. Besides the combination of learning with different technology and in different technological environment, there are other meanings. For example, Professor Li Kedong believes that in form, blended learning is to blend on-line learning and off-line learning. But on deeper levels, it includes the blend of instructional modes based on different instructional theories (such as constructivism, behaviorism and cognitivism); the blend of teacher-led activities and students' participation as the subject, the blend of different learning environment such as that of classroom teaching and that of online learning; the blend of different teaching and learning media; the blend of classroom teaching and virtual classroom or virtual communities, etc. [3]. Lots of scholars and institutions regard blended learning and hybrid learning as synonyms, while some believe otherwise. For example, John Daniel believes that it would be more helpful to our research if we regard hybrid learning as a certain form of blended learning [7]. Bates (as cited in Daniel) assumes that learning environment is a continuum starting from face-to-face learning with no technology at all to full distance learning. He refers to all kinds of combinations of technology and classroom teaching between the two ends as blended learning. Therefore, hybrid learning, as Bates understands, is to redesign the whole teaching and learning system to maximize the synergy of face-to-face instruction and online learning rather than apply technology to teaching and learning randomly.

The author of this paper believes that between an entire face-to-face instruction to an entire online learning, if we take possible combinations of technology and classroom teaching as blended learning modes, then theoretically speaking, there are infinite new modes. However, speaking from technology, there are simple technology and complex technology, as well as single technology and technological solutions; speaking from knowledge (content) and ways of learning, there are receptive, inquiry-based, independent, cooperative, project-based, etc.; speaking from cost-effectiveness, there are high invest high output, high invest low output, low invest low output and low invest high output. The reason we promote blended learning is to solve learning problems and foster life-long learning ability for learners with low invest, high output (or at least high invest, high output) and find effective ways of learning with the help of appropriate technology or technological solution. Therefore, the infinite theoretic new modes of blended learning are reduced significantly and technology, content and ways of learning will be permutated and combined. The ones that demonstrate high output in solving learning problems will stand out in practice.

A high output combination does not equal to a high technology combination. High output should be the fundamental appeal of adopting blended learning. Departing from the original intention of solving learning problems effectively, any kind of blending is meaningless. Professor Liu Yunshan posed a question in a symposium not long ago: why do people lose the ability and courage to control their own learning in institutional schools? She pointed out that education today is so expensive and complex that how to avoid teaching and learning with technology turning a new technology kidnap and exceeding the real need of learners becomes a serious question for us practitioners (2016). The basis of hybrid learning is non-separable combinations. And for a learning process, what is hybrid, or how to define non-separable combinations of technology, content and ways of learning? This question can only be clarified with introducing the concept of output. For certain output, in some blended learning, technology could only be a common tool or measure, while in other kinds of blended learning, technology could be a dispensable element, and this will become increasingly distinct with the development of smart education.

2.2 Modes of Blended Learning Reaching Maturity

During the last 2 decades, especially during the last 5 years, application and practice of ICT in education in primary and middle schools, China, are mainly about improving ICT literacy, narrowing educational gap, improving educational quality and promoting teachers' professional development. "Using ICT in class, often use it and have more people use it" advocated by the nation has seen initial success. Face-to-face instruction with no technology at all is reducing, while various modes of blended learning are forming, and fully online primary and middle schools are very rare. This may be the new normal of blended learning in primary and middle schools in China till 2020. The author summarizes three major modes:

2.2.1 Using Quality Educational Resources to Teach and Learn

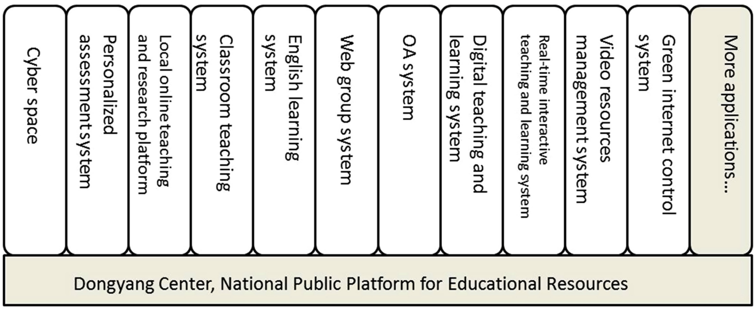
This mode started at the beginning of using ICT to facilitate teaching and learning. Along with the development of technology and the evolution of application needs, this mode got enriched and developed gradually and formed diverse sub-modes. For example, computer-assisted instruction in the 1990s; distance education at the beginning of this century, i.e. using technological measures such as satellite to provide educational resources to primary and middle schools in the remote areas and thus help teachers to improve their teaching quality; MOOCS proposed by some scholars these years, i.e. schools enjoying quality educational resources provide classroom resources for schools in the remote, rural areas and help teachers there prepare and conduct the lesson with educational resources developed by the urban schools; flipped classroom, i.e. organizing students learn by themselves with educational resources provided by teachers and discuss and communicate in class. All the sub-modes share the feature of changing the educational content and its ways of supplying.

2.2.2 Using Recording and Playing System to Realize Real-Time Teaching and Learning

This mode takes advantage of remote video conferencing technique and realizes interactive teaching and learning between local and far-end students. It is a typical representation of borrowing techniques from other fields to education. This mode has been put into practice at the end of last century, however, due to the complexity of technology and high demand of equipment, it requires for support from professionals on the spot, and therefore has not been promoted widely. Along with the improvement of remote interactive technology and the popularization of its application, this mode is becoming a normal way of teaching in some schools and areas China, such as in Chengdu No. 7 Middle School, the High School affiliated to Renmin University of China, Anhui province, Xianning city, Hubei province and the western area of Hunan province. The sub-modes include: teachers from central schools teach students from rural primary schools or teaching sites through online conferencing system (recording and playing system); schools enjoying quality educational resources teach students from their own schools and students at the other end simultaneously; schools enjoying quality educational resources and rural schools conduct thematic learning communication. The major characteristic of this mode is adopting real-time interactive technology and enhancing the sense of presence in the students' learning process, and thus integrate teachers and students from schools enjoying quality educational resources as learning resource into the process. What is worth mentioning is that, many areas record the real-time teaching and put it on the internet, so that students can review them whenever they need. In this way, the real-time recordings become new generated quality educational resources.

2.2.3 Using Cyber Learning Space to Teach and Learn

This mode is being studied and explored in recent years, and it has demonstrated the advantage of internet thinking extending learning performance constantly in regional practices. Professor Zhu Zhiting and others proposed that the essence of "Connecting schools with cyber learning space" is to transform learning space from a single physic learning space to the co-existence of physic space and cyber space, and enable teachers and students to teach and learn through "the learning network". "The learning network", on one hand, is to support learning with network, and on the other hand, is to construct the network in learning [9]. The author holds that the latter is the major difference of this mode comparing with other modes. It integrates various kinds of content, single techniques and interpersonal relationships through the online platform, and attempts to help teachers and students learn with the network conveniently, and form an online learning commonwealth simultaneously. The form of online learning commonwealths can not only share quality educational resources and receive lessons of elite teachers, but also, it could also possibly generate new process of cooperative learning in learning communities. From the experience of pilot areas of large-scale application of the national platform, teaching and learning with the educational cloud works in favor of teachers' leading students to explore subject knowledge and realizing the normalization of applying ICT in educational processes. Dongyang city, Zhengjiang province experimented the integration of ten major applications on the cyber learning space. The open of student learning spaces spurred informal learning. Teachers conducted preparation and research of lessons on the platform, and collective wisdom saved time for them, improved the quality of their lesson preparation, helped them building efficient classroom teaching and learning, and solved the problem of monitoring the schedule of teaching and learning. A Chinese subject teaching researcher in Dongyang said: "there are more than 1000 Chinese teachers in the whole city, and regular teaching research activities cannot reach every teacher, especially for some remote, small schools, due to the heavy conflict between work and professional development, their teachers may not attend one single teaching research activity for a whole year. However, the online platform enables them to attend the research activity in their rooms. It helps teachers improving their professionalism, and should be popularized everywhere." Schoolmasters in Dongyang became increasingly attached to the platform to conduct accurate teaching and learning evaluation. Through statistical analysis on the platform, they could find the gap between brother schools and their own school, and they could adjust their teaching and learning strategy, conduct pointed guidance to get better results. Along with the gradual advance of smart education, schools, teachers, students and parents are not satisfied with basic applications of the platform. They offered advices and explored feature applications through many ways. The application mode transformed from single application to mixed application, from exemplary demonstration to daily teaching. Highlights sparkled and typical applications stood out. A new ecological environment of education among teachers, schools, regions, parents and schools was built, which fully displays the advantage of using cyber space to teach and learn [1].



3.1 Integrations of Applications on the Platform

What needs to be clarified is that there could be different summarization of modes of blended learning, and the way the author of this paper summarizes blended learning originates from the mainstream idea that blended learning is the combination of face-to-face instruction to online learning, and is discussed from the viewpoint of how digital media and internet technology interact with the teaching and learning process. Meanwhile, the author accepts that there could be other ways of summarization, even better summarization, such as from the viewpoint of learning modes, etc.

However, there are three reasons that the author titles the above-mentioned three modes with “modes reaching maturity”: first, these are not theoretical modes, but modes came from practice; second, they do not require a lot from the teachers or the learners, but could be mastered with simple training and practice; third, hardware and software products and services constituting these modes are mature and selectable. These three reasons form conditions for promoting them in a larger scale.

3 Teacher-Student Relationship in Blended Learning

3.1 Teacher, Learner and Learning Content in Blended Learning

The traditional face-to-face instruction is constituted by the three fundamental factors: the teacher, the student and the learning content. The introduction of technology adds one factor. The fourth factor, through changing the way of presenting content, transmitting and interacting, combining with instructional design, fosters a series of new modes of instruction. These new modes are changing the process of teaching and learning and thus help learners learn more conveniently and more efficiently. The author finds that the relationship among teachers, learners and learning content change from being three factors to a three-dimension spatial relationship, that is to say: if regarding teacher-learner separate instruction as a point, and the behavior of teachers is the process of this point radiating to the two ends, then one end is face-to-face instruction, and the other end is tutorial; students’ learning behavior also radiates from teacher-student separate learning, with one end as collective classroom learning, and the other as independent and individual learning (including online cooperative learning); and the ways presenting learning content is changing from single source and single media to multi sources and multi medias.

3.2 Teachers in Blended Learning

Main responsibilities of teachers in blended learning are:

—Instructional design. Compared with instruction in an internet-free environment, the instructional design of teachers not only needs to take textbooks into consideration, but also the affluent internet environment and resources. Teachers need to set relations among the instructional goal, online and offline educational resources with the real life of students and thus help the students to construct knowledge and form positive feeling and value orientations.

—Imparting knowledge. The same as face-to-face instruction, teachers could still impart knowledge face to face and in a real-time manner. Through assigning multi-media learning content for students and through the “reading” of the content, they could help students with their internalization of knowledge. Imparting knowledge often can be seen in collective classroom instruction, and in the first two modes of blended learning discussed in this paper, the display of this function of teachers is very common. Imparting knowledge is necessary in most instructional processes in primary and middle schools nowadays, but still we need to attend to the way of doing it.

—Creating learning communities. If the teacher changes the learning organizing form, the situation will change. For example, Xuzhou city of Jiangsu province launched the “Learn and Tell” action plan, which requires teachers in their teaching, ensuring students’ input by encouraging their output. Many teachers adopted the measure of cooperative team learning. The author of this paper observed their lessons and found in classes like these, learning resources not only include assigned content from the teachers, but also mutual inspiration and communication among the team. This could even happen in a class conducting lessons with teacher-oriented classroom recordings. One teacher, when answering the author on the advantage of remote real-time teaching and learning, says: “my students could learn together with the best students in the urban areas, and it does my students a lot of good watching them study. Occasionally, my students answer questions better than students in the urban areas, and this works as a very good incentive for them”. In “flipped classroom” launched by some schools, mutual help among students are also applied. The teacher divides students into different groups and learn beforehand, pose questions, answer them mutually and proposed questions unable to solve in the class organized by the teacher.

—Pointed guidance. Compared with collective, face to face instruction, in a blended learning environment, it is more possible for teachers to spare more time and energy to observe students and offer them in-time guidance. Different from collective instruction, rather than leading students according to the teacher’s own pace, he or she can walk into the learning process of the student. The teacher can even offer individual prompt and guidance through checking to what degree students complete their learning tasks. Especially with the help of the learning analyze software, the teacher can access more data with more accuracy through assessing learning tasks submitted by students. The application case of English learning improvement in Dongyang mentioned in the third mode of blended learning in this paper is based on this method, only the data used is not for a specific lesson nor for a specific class, but for a certain subject in a certain period of time in a certain region.

—Fostering online learning communities. The concept of online learning community is not widely used in China now yet. Search full text for “online learning community” or “learning community + internet” in cnki.net and only 19 relevant thesis can be found. The earliest appearance of online learning community is in a thesis introducing related trend in Malaysia and the thesis was published in 1999. It was not until 2005 that we saw independent theories and practices domestically, while the heat remained low. However, the author believes that this new learning ecological environment will be the major path of blended learning getting success. Different from face-to-face collective instruction, and different from learning commonwealths created and organized by teachers, online learning community are often organized by learners themselves and it linked more than learners themselves, but also interests and human nature. When a learning community exceeds learning relations among people, but goes deeper to learning interest and need, to the identification and understanding of the value of learning, the influence of this learning community is high. Then this learning community could achieve maximum effect with little effort whether in starting a formal learning task or an informal learning exchange. Cases on this are not adequate, however, we could see some prototypes from the teaching and learning with cyber learning spaces. Teachers should guide students to attend communities like this, and share with students experiences from different learning communities and thus improve benefit.

From the above it is safe to tell that most of the jobs of teachers are instructional design, observing students and guiding them. And instead of direct guidance, most of the guidance may take the shape of setting up learning commonwealths, fostering online learning communities, etc. Teachers will get help on educational resources, application software and internet services, etc. These helps will not only extend the teacher's brain, but also improving his or her ability of organizing and leading in the instructional process.

3.3 Students in Blended Learning

Except for computer-assisted learning, in other modes of learning, students could play multiple roles besides learners. Possible roles mainly are:

—Knowledge supplier. Learners in blended learning could be the knowledge supplier. On the one hand, they need to communicate what they have learned; on the other hand, the sharing of acquiring knowledge itself could be learning resources for others (as discussed in the case of remote real-time teaching in this paper).

—Imparter of knowledge. Due to the emergence of learning commonwealths and learning communities, when some learners share his or her learning process and outcome, they actually assume the role of the imparter of knowledge. In some kind of learning, students could learn faster than teachers, for example, ICT learning, informal learning, and sometimes students could even be the teacher of their teacher.

—Learning scaffold for classmates. There are more online and offline communication between teachers and students and among students in blended learning, thus, the different knowledge basis, learning style and cultural background will have more influence towards the achieving of the goal of learning than that in face-to-face instruction. Both the teacher and student can solve their own problems more efficiently through paying more attention to the learning process of others. The student can be the learning scaffold of each other.

—Helper of the teacher. If in blended learning, the teacher gives the student more opportunity on independent learning, cooperative learning, project-based learning and inquiry-based learning, then the student could be the helper of the teacher. In this instructional environment, the student's questions can go beyond the teacher's preparation, and this will be a huge challenge for the teacher. An excellent teacher should organize communication before, during and after class, deepen the instructional process by taking full advantage of the knowledge source provided by the student, master courage to learn together with the student and accelerate his or her professional development.

4 Discussion on the Future of Blended Learning

The author believes that blended learning will be the main instructional form in the next 5–10 years, and will have major influence on the student's deepening of knowledge learning, technology acquirement and proper values of worth. The Chinese government has already proposed that "ICT in education should expand to supporting networking ubiquitous learning rather than only serving classroom instruction. We should take full advantage of the mature technology and platform to integrate instruction, learning, management, etc.; expand the outreach of the classroom; promote coordinately the application of the cyber learning space which is real name certified, systemized, manageable and also controllable; promote traditional education and education with ICT to compensate for the shortcomings of each other; lead teachers to conduct teaching activities such as preparing and giving the lesson, tutoring, etc. on the platform. Encourage independent learning, individual learning and cooperative learning of the student. Support schools to carry out comprehensive assessments of the student, comprehensive analysis of instruction to improve the efficiency of management and alleviate burdens of the teacher and the student". There are reasons to believe that teaching and learning practices in primary and middle schools will be carried out to a deeper level and to a wider scale.

Blended learning requires more support from educational environment and resources than face-to-face instruction, and therefore, after basically forming the online educational environment, how to enable the teacher to access quality resources will be a question calling close attention and serious solution. The Chinese government proposed to "explore new supply mode of educational services. Encourage internet enterprises and social educational institutions to develop digital educational resources based on the need of the market, provide online educational services. Encourage schools to explore new models of online teaching and learning through using digital educational resources and educational service platforms; expand coverage of quality educational services to advance equity of education. Encourage schools to access online and offline educational resources and explore new supply models of public education, such as primary and middle school education, vocational education through cooperating with enterprises and other ways." This act will serve as the vigorous driving force for blended learning.

Professional development and value of education of teachers still will be important factors influencing the development and quality of blended learning in China. Whether the teacher teach to complete instructional task or ensure the student learn, whether the teacher teach for the development of the student or for better grades; whether the teacher value their own authority in imparting knowledge or learn together with the student in an open mind; whether the teacher value textbooks and teaching materials or help the student learn with online resources and life experience… the different values in education will have direct influence towards the development of blended learning. Thus, further strengthening teacher training, improving their knowledge and experience and professional teaching are the basis of the advancement of blended learning.

The author believes that along with the development of ICT in education in China, blended learning will shift from more adoption of quality educational resources and real-time interactive teaching and learning to more adoption of learning commonwealths combining face-to-face instruction and online learning. "Connecting schools with cyber learning space" is the major carrier of this mode. Along with the improvement of teachers and technology, blended learning in China will develop step by step to hybrid learning.

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Strategies and Solutions

Blending Smart Phones into Regular Classroom Learning

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Abstract. Classroom teaching and learning is the key component in formal education. How to engage the students in the limited classroom learning with emerging technologies has interested the researchers and practitioners in recent decades. We designed a personalized and web-based vocabulary drill system targeted at the required new words and phrases from the English textbook of the university students, and asked the students to volunteer in doing the drill programs using their own smart phones via wireless network in the classroom for 10 to 20 min in every week's English class. The quasi experiment in one semester resulted in the significant grade mean increase of the treatment class in vocabulary test, as well as the decrease of the grade mean distance in the regular exams from the treatment class to the control class from statistically significant level to not significant level. Moreover, the fully participating students in the treatment class achieved significantly better grades than the partially participating students in the post regular exam, although the two groups were almost the same in pre regular exam. The present research demonstrates that the students' smart phones can be easily blended into university classrooms to effectively facilitate the teaching and learning in university classes.

Keywords: Smart phone · Instant feedback · Classroom teaching and learning · Blended learning · English class

1 Introduction

Because of its high quality-price ratio, the smart phone has been popularly used worldwide, and especially by young students. For example in China, according to the latest internet survey published on July 23rd, 2015 by China Internet Network Information Centre, up to June 2015, the internet users using smart phones counted 594 Million. Students across all educational stages were the largest population, accounting for 24.6 % of all Internet users. The Internet users aged between 20 and 29 accounted for 31.4 %, the largest proportion of the total. Weekly average online duration of the Internet users in China reached 25.6 h. However, according to the same Chinese survey, among all kinds of Internet functions owned by smart phones, instant

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messaging, search engine, online news, and others, rather than online education, are most used by the Internet users and absorbed into the fabric of their daily lives.

Powered with the high computing capability comparable to a personal computer, the multiple functions from instant voice and text communication, multimedia to Internet browsing, and more affordable price compared with notebook and laptop computers, smart phones available in the hands of the students mean that there is no need for the institution or the teacher to provide learners with the special hardware in order to incorporate a technology enhanced learning component into their teaching context [1].

2 Related Work

The value of in-class mobile phones and other mobile devices usage to student attentiveness, engagement, and learning performance remains both controversial and filled with promising potential. It is investigated through both questionnaire survey and quasi-experimental approach.

Many researchers studied the use of mobile devices in the classroom and their effects on classroom learning through questionnaire surveys. Samson [2] gave the university students the option to use LectureTools, an interactive suite of tools designed specifically for larger classes, so that over 90 % of students attending lecture voluntarily brought their laptops to class. LectureTools also led to a dramatic increase in the number of students posing questions during class time, with more than half posing at least one question during class over the course of a semester, a percentage far higher than achieved in semesters prior to the use of this technology. Students' surveys over multiple semesters demonstrated their more attentiveness with the technology, significantly more engagement, ability to learn more with the technology than in similar classes without it, as well as their belief that the availability of a laptop is more likely to increase their time on tasks unrelated to the conduct of the course.

Kay and Lauricella [3] collected both quantitative and qualitative data of an anonymous survey from 177 undergraduate university students (89 males, 88 females) to analyze and assess beneficial and challenging laptop behaviors in higher education classrooms. Sample in-class laptop-based activities included online surveys (e.g., assessing gender roles, outlook on family issues), web-based research on assigned topics (e.g., social factors in historical perspective), interactive case studies to improve communication skills, creation of family genograms using online charting software, viewing online videos, reviewing published articles, consultation and discussion of websites and online philosophy game. In addition, all class activities, notes, and PowerPoint presentations were posted on a Learning Management System (LMS). Key benefits observed include note-taking activities, in-class laptop-based academic tasks, collaboration, increased focus, improved organization and efficiency, and addressing special needs. Key challenges noted include other student's distracting laptop behaviors, instant messaging, surfing the web, playing games, watching movies, and decreased focus. Nearly three-quarters of the students claimed that laptops were useful in supporting their academic experience. Twice as many benefits were reported compared to challenges.

Those studies based on students' survey would be more persuadable if the students' opinions expressed in the survey result could be validated by their actual learning performance by using the laptops in the classrooms. Therefore we will review some empirical studies which are focused on the effect of mobile learning on students' academic achievement.

The usage of mobile phone's short message service (SMS) for sending learning materials is often studied. Lin and Chen [4] reported the preliminary results of a study of the effect on L2 English learning of podcasts sent to college students' smartphones via e-mail. Twenty-five volunteers exploited publicly available podcasts targeting specific vocabulary items and grammar points sent to them twice daily for a month. A post-test after the first two weeks confirmed large gains in listening ability, vocabulary learning and grammar knowledge. In the above two cases, the mobiles function just as the information receiver, but not as a smart and interactive computer.

Kim [5] investigated the effectiveness of using SMS in L2 English vocabulary learning. The study involved 62 university students in three English classes. One class was a control group that received only class instruction; the second class received SMS with no interactivity; and the third received SMS with interactivity. Students who learned vocabulary with SMS outperformed the control group, and those who received SMS with interactivity learned significantly more words than those without it. In this case, the interactivity feature of mobile phones is studied, despite its limitation just with textual information.

Besides SMS, the smart phones' multimedia and interactive function have been more and more used for learning in classroom, and its effectiveness on students' learning performance has been investigated. Lin et al. [6] used tablet computer with fill-in blank quizzes to deploy computer supported collaborative learning in English vocabulary activities of two group members. The outcomes after the completion of learning activities of 20 5th graders and the statistical results of after-class questionnaire and interview implied that this Tablet PC enhanced instructional design indeed aroused students' motivations, improved their mutual interactions and their English vocabulary. While this paper reported just a pre and post- test research with a small sample, it acknowledged that long term effects between control group and experiment group will be analyzed and evaluated in the further research.

Munoz-Ashour et al. [7] described an experiment to send students' mobile devices in class contextualized learning pills in order to engage more students in the classroom learning. A learning pill is a simple exercise that summarizes some key concepts explained in class and promotes reflection and self-study. The students were expected to submit their answers to the professor by e-mail in the 24 h following the class. The professor reviewed the answers and provided feedback to the students by e-mail so that they could reinforce or redirect the results of their reflection exercise. In this experiment, the students' mobile phones were used just as the receivers of the exercises, while the instant feedback and interaction feature of the mobile phones was not utilized at all. The average course grade of total 50 students in 2010 is 5.2 out of 10. The average grade of the students attending classes but not consuming the learning pills was 4.86, while those consuming the pills had an average grade of 6.49. The p-value for the t-test in this case is $0.00096 \ll 0.05$, and therefore the null hypothesis can also be rejected. The number of students consuming or not consuming the learning pills was not introduced in the paper, but can be inferred from the above average grades, i.e., about 10 students consumed the learning pills, while the other 40 ones did not consume them. Therefore the actual treatment student number is much smaller than the control students in this study, and this unbalance may influence the reliability and validation. The rate of students attending more than half of the classes was slightly improved, by 3.5 %, comparing the offering of the course in which the learning pills were used to that in which they were not. The student survey showed that the use of learning pills has a positive impact on the evolution of the motivational states of the students over the duration of the course. This is especially true for intrinsic motivation, while being less noticeable for external motivation. However, the number of respondents to the survey is not declared in the paper.

Uluyol and Agca [8] empirically compared text-plus-mobile phone learning with three other conditions described in multimedia learning theory: text-only, text-plus-picture, and computer-based (animation-plus-narration). The text-plus-mobile phone learning means that the learner scanned the tag in a 2D barcode near the printed text with the camera on his/her mobile phone and reached the animation and narration on the mobile phone's screen. A total of 188 students (95 males and 93 females) from three universities participated in the experimental study. They were randomly divided into four groups with 47 students per group, corresponding to the four experimental conditions. No significant differences existed among the four groups in pre-test. All four conditions were tested individually in a laboratory session lasting approximately 40 min. A one-way ANOVA test was used to assess the effect of the four conditions on retention and transfer. The effect of condition was significant for both retention ($F(1\text{-}170) = 4.9$, $p = 0.003$) and transfer ($F(1\text{-}170) = 6.9$, $p = .000$). A Scheffe test found a significant effect between the text-only and text-plus-mobile phone conditions, between the text-plus-picture and text-plus-mobile phone conditions for retention scores, between the text-only and text-plus-mobile phone conditions, between the text-plus-picture and text-plus-mobile phone conditions for transfer scores, but no significant difference in retention or transfer scores between the paper-plus-mobile phone condition and the computer-based condition. Of the four conditions, the text-plus-mobile phone condition had the highest score on both retention and transfer scores, and text-only condition had the poorest retention and transfer results. Although this experiment demonstrated the advantage of mobile device usage for university students' retention and transfer of learning content over other approaches like traditional printed text and computer-based animation, it would be more reliable with much longer experiment time in order to decrease the influence of students' curiosity on their knowledge retention and transfer.

In summarization, among the above reviewed literature, many investigated the learners' subjective attitude and feeling towards learning with mobile devices in classrooms, some studied effect of mobile learning by sending learning materials to the students' phones through empirical experiments, and fewer explored smart phones' instant feedback and other "smart" function used by students in the classrooms and its effectiveness on their learning achievement. More empirical experiments lasting for a long period are needed to assess mobile devices' effect on learners' performance in regular academic exams. Therefore the present study is focused on the usage of smart phone's multimedia and instant feedback functions for academic purposes during class and its effect on students' learning performance in regular exams, and uses quasi-experiment with treatment and control class for a semester to ensure the reliability and validation.

3 CSIEC System and Learning Activities Design

CSIEC (Computer Simulation in Educational Communication) is an intelligent and personalized web-based system for the teaching and learning English as a foreign language [9] In previous studies [10], the students in treatment group from four diverse high schools in China used the CSIEC system with multimedia desktop computers in their computer pools during a school term or a school year, and achieved a better exam score improvement than the students from the control group that only learned with the traditional approach and were taught by the same teacher. After further development with responsive HTML 5 technology [11] the CSIEC system can be accessed by tablet computers or smart phones through wireless network.

"New College English 3" is the English textbook used by many Chinese universities and published by Shanghai Foreign Language Teaching Press. In each unit of this textbook, a list of key words and expressions are provided for the students to memorize. In CSIEC system, four types of vocabulary drill activities are designed for the targeted new words and expressions in each unit: crossword game, spelling & matching the words' pronunciation with its definition, blank filling and multiple choices in a real time quiz. We introduce the activities in the following subsections.

The first activity is a crossword game. The words in rows and columns of the crossword which one student faces are randomly given by the server system and different from the words which another student faces. After the student fills in the rows and columns and clicks the button "Check crossword", the server will check the correctness of the answers and give a grade. Considering the smaller screen of smart phones, we limit both the maximum rows and columns to ten words so that the students need not to drag the screen up and down many times to view the whole crossword matrix.

The second activity is a quiz to assess the listening, recall and recognition of new words and phrases in the unit. This quiz consists of questions for the new words and phrases in one unit. For every question, the student listens to the pronunciation of a new word or phrase, fills in the blank with the correct spelling of the word, and selects the corresponding Chinese explanation and possible English meaning, which are transcribed from the word list in the textbook.

Though the new words and phrases in a unit are specified, their order appearing in the quiz is randomly defined by the server system so that the quiz the student writes differs from each other. Moreover, the order of four explanation choices for a new word or phrase is also randomly defined by the server system. As soon as the student writes all the answers to the questions in the quiz and submits the answers, instant feedback about the grade in the quiz will be displayed.

In each unit, one crossword game and one word quiz for the required new words and phrases from the textbook were designed. Totally there were 8 crossword games and 8 word quizzes for the 727 new words and phrases.

While the first and second activities are aimed to help the students learn the new words and phrases by heart, the third and fourth activities are aimed to drill the students to use them in the sentences. The third one requires the student to write the missing word or word phrase in a given sentence. The fourth activity is to select one proper word or phrase from four choices to fill a meaningful sentence in a real time quiz. The former three activities can be accessed by the students at any time and asynchronously. The student can do them as many times as he or she wishes. During the fourth activity, however, the students can read the choice question in their own smart phones synchronously only after the teacher sends the question by herself with her computer or smart phone, and have to complete the question in a given time, for instance, 30 s. That is also the essence of so called real time quiz. The teacher can review the students' response after sending all the questions in a quiz. For every question, the answers to both correct and false choices are counted and displayed.

4 Research Hypothesis

Starting from the review of related works, we speculate that the usage of smart phones of the students in classrooms directed by the teacher for content-related drills has positive effect on the students' academic performance, exemplified by their scores both in drilled objectives and in the overall performance in regular exams.

5 Participants and Design

To evaluate the hypothesis we designed a quasi-experiment with university students that are usually allowed to freely bring their smart phones and other mobile devices to the classrooms. From October 2014 to December 2014, two classes in a technical university in Beijing, China, each with 60 freshmen, participated in this research. They were taught by the same English teacher, and learned the same content from the same English textbook, "New College English 3", and with the same time plan. As there was no wireless local area network on the campus, the students could only access the Internet through the third generation (3G) or the fourth generation (4G) networks of the phone carriers, i.e. the Internet service providers (ISP) such as China Telecom or China Mobile.

The students' grades in entrance English exam held at the beginning of this semester, i.e. in September 2014, showed very significant mean difference between the two classes. One is 69.61 and another is 71.85, and the P value in t-test (2-tailed) is $0.000 < 0.01$. The researchers decided to invite the students from the class with lower grades as treatment group to use the CSIEC system, and the students from the class with higher grades as control group. The purpose of this kind of research design is to assess the actual impact of the technology enhanced learning or blended learning on students' academic performance in the reality, but not in a deliberately created environment, just like one of our previous studies [12].

In the first period of both treatment and control class, the teacher asked if the students could bring a smart phone to the classroom and afford to browse the Internet through the phones' internet service provider. The answers from more than 90 % of the students were positive. As freshmen, most students have bought a new smart phone and bought cheaper voice and data package provided by an ISP. Therefore every student in the treatment class was given a user ID and password to login to the CSIEC system. During two hours' class of every week in the semester from September 29th 2014 to December 29th 2014, the teacher first implemented the traditional teaching plan. In the last 10 to 20 min of the class, the teacher asked but not required the treatment students to participate in the CSIEC system: first use their own smart phones to connect to the Internet, login to the CSIEC server, and complete the crossword, word quiz and other activities. Certainly they could still use the system outside the classroom, or in their free time. The teacher could present the students' grades in a quiz using the beamer and the large curtain in the front of the classroom.

The students in the control class were asked to learn by heart the new words and phrases through traditional approaches. We designed a vocabulary test to assess the word recall and recognition skill of the students besides regular tests, which the treatment and control students were required to write to get the course's semester grade. It has 50 questions selected from eight word quizzes for the eight units. In the first period of both experiment and control class, i.e., on September 29th 2014, the students were asked to write the vocabulary test using their mobile devices. In the last period of the two classes, i.e. on December 29th 2014, the students were asked to write the same test again. Thus the first test is regarded as the vocabulary pre-test, and the second test is regarded as the vocabulary post-test.

6 Experiment Results

In the pre-test, the grade mean of 40 participating treatment students is 80.96, while the mean of 46 participating control students is 80.95. The mean difference 0.01 is statistically very trivial ($p = 0.997 > 0.05$). Thus the treatment and control class were equal in vocabulary knowledge before the experiment. In the post-test, the grade mean of 39 participating treatment students is 92.27, while the mean of 41 participating control students is 87.58. The mean difference 4.69 is statistically significant ($p = 0.04 < 0.05$). Because the vocabulary test content in the post-test was the same as that in the pre-test, the longitudinal grade compare of either the treatment group or the control group is meaningful. The average grade of the treatment students in vocabulary test was increased (11.31) more significantly than that of the control students (6.63) throughout the experiment. In order to compare the effect size of both classes, the Cohen's d based on sample size considering Hedge's adjustment is calculated [13–15]. It is 0.261 for the treatment group, while 0.167 for the control group.

It is worthwhile to notice the participating numbers both in the pre-test and in the post-test. Because both the treatment students and control students were invited by the teacher, but not obligated to participate in the research, the student amount varied between two tests. After inspecting the participating students, we found that 28 treatment students and 35 control students were involved in both tests. The treatment students were advantaged over the control students with 1.73 in the pre-test at statically not significant level ($p = 0.636 > 0.05$), but gained more advantage over the control students with 5.86 in the post-test at statically significant level ($p = 0.021 < 0.05$). The treatment group made greater progress (10.76) than the control group (6.64). The paired t-tests to compare the means in the pre-test and the post-test of both the treatment group and control group show significant difference ($p = 0.000 < 0.01$ for treatment group and $p = 0.019 < 0.05$ for control group). The Cohen's d based on sample size considering Hedge's adjustment is 0.914 for the treatment group, while 0.526 for the control group.

To compare the academic performance of treatment and control classes throughout the experiment, we also collected the students' grades in the regular exams before the experiment and in final exam. The entrance exam in September 2014 before the research was regarded as pre-test, and the final exam in the beginning of January 2015 after the research, was regarded as the post-test. All the test papers and content in those exams were designed not by the teacher herself, but by the English teaching unit of the university. Besides the students in this research, all other students in the same grade of this university needed to write the regular exams, too.

The control students were advantaged over the treatment students with 2.68 in the pre-test at statically significant level ($p = 0.002 < 0.05$), but the advantage was decreased to 1.39 in the post-test at statically not significant level ($p = 0.256 > 0.05$).

In the pre-test, the grade mean of treatment class was distant from the grade mean of control class at statistically significant level ($p = 0.000 < 0.01$). In the post test taking place at the beginning of January 2015, the mean distance from treatment class to control class was observed again but at not significant level ($p = 0.263 > 0.05$). Throughout the usage of CSIEC system in and outside the classroom with mobile devices, the treatment students decreased their grade distance in regular exams to the control students from a statistically significant level to a statistically not significant level.

It is valuable to analyze the students in the treatment class in more details. Because this quasi-experiment is a voluntary activity for the students, twenty-eight students participated in both pre-test and post-test, and can be called full treatment students group, while the other thirty-two participated only in pre-test or in post-test, and can be called partial treatment students group. What is the difference of the learning behavior with the CSIEC system between the two groups of students and their corresponding performance in the vocabulary tests and regular exams?

Based on the report and log function of the CSIEC system, we calculated the number of completed activities and the summarization of activity scores for every student, and compare their means and the score means in regular exams between the two groups. The full treatment students show statistically significant advantage in the number of completed activities and score summarization over the partial treatment students. It is unreasonable to compare the mean grade of two groups in vocabulary pre-test and post-test, because some students from the partial group just attended pre-test, or post-test. However, all students attended all regular exams, so we can compare the performance of the two groups in regular exams. In the regular exams, the two groups were almost equal in pre-test (69.70 vs. 69.53, $p = 0.849 > 0.05$), but statistically different in post-test (83.71 vs. 80.48, $p = 0.0399 < 0.05$).

7 Discussion

The analysis of exam data confirms the significant and positive effect of smart phone usage in English teaching and learning in university classrooms. The effectiveness can be explained by the feature of instant feedback supported by the smart phone and the web-based CSIEC instruction system. The treatment enabled the students to get familiar with pronunciation, spelling, meaning and usage of the new words and phrases through participating in the drilling activities supported by the smart phones in the classroom and in the free time. As vocabulary is the basics of language skills including listening, speaking, reading and writing, the vocabulary improvement contributed to the students' progress in comprehensive and regular exams. Thus the students from treatment class decreased their distance to the control class in regular exams on average from statistically significant level to not significant level throughout the experiment semester. Moreover, the fully participating students in the treatment class achieved significantly better grades than the partially participating students in the post regular exam, although two groups were almost the same in pre regular exam.

The present research supplies a reliable experimental evidence to previous studies investigating the students' perceived usefulness of mobile phones for learning through survey approaches [2, 3], extends our previous research from personal computers [10] to tablet computers or smart phones, and validates again the conclusion from previous experimental studies in the literature review that mobile phones can have positive effect on students' learning performance [6–8]. Furthermore, this research differs from [8] in much longer experiment duration, i.e., one semester, and the full usage of the instant feedback feature of smart phones. It also differs with Lin et al. [6] in both treatment and control group for a long-term experiment. Compared with Munoz-Ashour et al. [7], which utilized mobile phones' information receiving function and used unbalanced treatment and control group, this research utilized the phones' multimedia function and "smart" function of automatic and instant scoring and feedback, and the sample size of treatment and control group is also balanced. The feature of full usage of mobile phones' smart functions also differs this study with previous studies that just send students textual learning materials through SMS function of mobile phones [5, 6]. The control students also brought smart phones with them into the classrooms, just as the treatment students. But they were not allowed to access the drilling resources for all units. In the classroom, they might use the smart phone to browse internet news, chat with others, write emails, view videos, go online shopping or do other things, all of what had nothing to do with the learning content. Because smart phones like other portable devices can serve as a distraction when used in uncontrolled and non-directed contexts [16], and even lead to lower exam grades [17–20] and anxiety [18], the control students made less academic progress than the treatment ones.

Rambe and Bere [21] argued that one of the most complicated academic endeavors in transmission pedagogies is to generate democratic participation of all students and public expression of silenced voices. The present research attempted to encourage all students to participate in the learning activities with the help of their own smart phones by writing or selecting the new words or phrases, submitting the answers, getting corresponding feedback instantly, and comparing their performance with each other.

However, the participants' number in the post-test was less than that in the pre-test, as observed both in treatment class and control class. The reason may lie in that the designed learning activities were not required as the obligatory work by the teacher, but would cost so much effort and time of the students that some students gave up these activities.

8 Conclusion

We designed the vocabulary exercises to drill the university students to master the required new words and phrases from the English textbook by letting the students do the drill programs using their own smart phones via wireless network in the classroom for 10 to 20 min in the English class per week for two months and outside the classroom. The quasi experiment in one semester resulted in the much more significant improvement of the grade mean of the treatment class than that of the control class in vocabulary test so that the grade mean difference of the two classes was increased from nearly null to statistically significant level. In the regular exams, the mean distance from treatment class to control class both with 60 students, was decreased from statistically significant level to not significant level. In addition, the fully participating students in the treatment class achieved significantly better grades than the partially participating students in the post regular exam, although the two groups were almost the same in pre regular exam. Our research hypothesis is established. This quasi-experiment demonstrates the significant positive effectiveness of smart phones used in regular university classes by the students on their academic performance, and suggests a useful framework to connect the intelligent feature of smart phones with language learning activities, which is needed in mobile assisted language learning [22].

Although the conclusion based on the test scores seems promising, there are some limitations to this work. Despite the fact that most students had smart phones, the participants in the vocabulary pre-test and post-test counted about 70 % of all students, and the students participating both in pre-test and post-test counted only about 50 % of all students. How to engage all the students to the learning-related use of smart phones in the classrooms is still a valuable question and deserves future exploration. Furthermore, the learning content and form of the web-based CSIEC instructional system itself should be improved to be more adapted to smart phones.

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Action Research on Visualization Learning of Mathematical Concepts Under Personalized Education Idea: Take Learning of Geometrical Concepts of Elementary Math for Example

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Abstract. Mathematical concepts are usually abstract and logic-related. Pupils need to master a lot of mathematical concepts to smoothly solve mathematical problems and conduct mathematical reasoning and judgments. However, at the transition stage from specific image thinking to abstract logic thinking, pupils have difficulties to understand abstract mathematical concepts. Based on learning activity theory, this paper proposed five activities of visualization learning, namely, situation, thinking, interaction, lucubration and evaluation. It aims to cultivate the pupil's abilities on independent learning, mathematical thought, cooperative exploration, acquiring and restructuring of knowledge, and proposing and solving problems. Through two rounds of action researches, these were applied to learning geometrical concepts of elementary mathematics. The evaluation results showed that the visualization learning of elementary mathematics can improve learning abilities.

Keywords: Visualization learning · Personalized · Elementary mathematics · Mathematical concepts

1 Research Problems

1.1 Existing Problems in Learning Concepts of Elementary Mathematics

Mathematical concepts are the reflection of general and essential features of related quantitative relations and spatial forms of practical world in human brain [1]. Usually, mathematical concepts are abstract, and pupils need to learn a lot of mathematical concepts as the foundation for solving subsequent problems and conducting smooth mathematical reasoning and judgment. However, as pupils take image thinking as the main body of cognition, it is difficult for them to learn highly abstract mathematical concepts. As a result, the learning of concepts becomes a difficult area in learning elementary mathematics [2]. At present, there are many problems in learning concepts of elementary mathematics: (a) stressing the importance of result, but paying little attention to exploration and developing process of students [3]; (b) placing high value

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on image thinking of students, but undermining the training on their abstract thinking [4]; (c) students being lack of opportunity for independent practice so students cannot connect living experience with concepts learnt to solve actual problems in life [5]; and (d) ignoring formation and connection of concepts, thus leading to the problem of fuzzy concepts [6].

1.2 Advantages of Visualization Learning Method

Related current researches showed that APPs can be used to visualize knowledge to drive interaction of students and establishment of learning link so as to drive their learning of mathematical concepts [7]. By enhancing reality technology or 3D visualization technique or visualizing knowledge, knowledge can be presented with animation, video and interaction software to improve learning interest of students [8, 9]. In teaching, visualization is conducive to cultivate students' intuitive thinking, divergent thinking, image thinking and innovation thinking [10] and improve cognition structure of students [11]. Data visualization method is beneficial to analyze collaborative learning of students [12] and work out scientific evaluation on learning of students.

The primary research questions to be addressed in this paper are: (a) How can visualization learning method support learning activity of geometrical concepts of mathematics? (b) What about the learning effects?

2 Literature Review

2.1 Current Situation of Related Researches on Learning Concepts of Elementary Mathematics

Research on mathematical concepts mainly focuses on teaching strategies and formation process of mathematical concepts. Yan proposed that teachers should use different presentation methods to change abstract into image, ask more yet to present less and formation of image-aid concept in teaching concepts [13]. Li thought variant and comparative analysis should be used for building concepts and shaping conceptual system at multiple levels [14]. Zeng proposed that introduction strategies of concept teaching can be used to introduce knowledge, emotion and problems [15]. Hong proposed the formation process of concept, including observation, analysis, analogy, guess, summary, generalization, and deduction, exploration and discovery of rules, and perception of new concepts of mathematics, so as to make students experience the establishment process of mathematical concepts [4].

Analysis on related current studies showed that qualitative research is the main one on learning concepts of elementary mathematics and it is mostly summary of experience, but to be short of research on learning concepts of elementary mathematics based on problems appeared and empirical research. It is necessary to conduct empirical research to explore teaching methods to solve actual problems in learning concepts of elementary mathematics.

2.2 Current Research of Visualization Learning

Constant development of visualization technique in recent years makes more and more educators focus on research of visualization learning. Klerkx applied visualization technique to support learning process' exploration, understanding, collaboration, self-evaluation and design [16]. Eppler and Burkhard thought that knowledge visualization means to apply visual representation method to drive spreading and innovation of group knowledge and knowledge visualization is to study the roles of visual representation in improving knowledge spreading and innovation between groups [17]. Koralcalcis adopted three-dimensional technique to visualize scientific knowledge and applied it in learning science of grade 8, showing that interactive three-dimensional animation, display of three-dimensional animation and static three-dimensional illustration can be combined in learning process to drive students to learn knowledge better [8]. Marta et al. believed that the application of visualization in mathematics can drive students to solve problems and arouse innovative exploration and improve learning of mathematical concepts via visualization APPs [18].

Domestic scholars like Zhao studied visual representation of knowledge visualization, applied graph method to visualize knowledge and researched its application in learning process of different subjects [19]. Some scholars also established corresponding learning environment based on visualization. For example, Li and Wang designed mobile learning environment based on knowledge visualization [20]. Several domestic scholars also studied the application of thinking visualization in learning. Cui took thinking visualization instruments as teaching instrument and students' cognition instrument to promote domination of students' implicit knowledge and relieve cognition load of students [21]. Zhang took conceptual graph of thinking visualization instrument as evaluation instrument of mathematic teaching [22]. Some researchers also considered visualization as a method to cultivate students' thinking ability. Peng structured the strategies of cultivating divergent thinking based on mind map and tested its effectiveness of thinking ability and innovation ability's cultivation [23].

In summary, a lot of related domestic and foreign researches have conducted related studies on visualization learning and more attention has been paid to application of different visualization methods into learning concerned about subjects like mathematics, English and science. According to the related studies on visualization learning, at present, three visualization methods are mainly applied in visualization learning, namely, knowledge visualization, thinking visualization and data visualization. Related studies are mostly concerned about visualization methods, but without any related research on comprehensive application of several visualization methods in learning. So, the application of different visualization methods in learning is still at exploratory stage.

3 Activity-Based Visualization Learning Method

3.1 The Structure of Activity Learning System

Activity theory emphasizes the learner centered approach, which takes learning as the activities of subject point to object. Learning communities and instruments are play important roles in subject internalization. This theory is the foundation and theoretical basis of the design of visualization learning activities. Engeström believed that human activity is a system, he put forward the structure of the activity system [24] (as shown in Fig. 1). The activity system includes six elements: subject, object, community, instruments, rules, and the division of labor. In visualization learning, based on activity theory, students are the main body of activity system and knowledge and learning target are objects. Visualization resources and instruments are considered as activity tools. Then, it is teachers that help students to form learning team and develop community. Interaction between Learners is based on the utilization of visualization resources and instruments of thinking visualization.

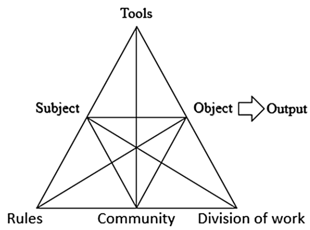

Fig. 1. The structure of the activity system

Stolyar, a mathematic educator of Soviet Union, proposed three-stage theory of mathematics' learning activity [25]. The first stage is to accumulate factual materials through observation, test, summary, analogy and generalization, and is known as the organization stage of experimental materials. The second stage is to abstract primitive concept and axiom from materials accumulated in the first stage. Based on such concept and system, mathematical theory is deduced. The stage is known as logic organization stage of mathematical materials. The third stage is concerned about application of conclusions in the previous stage, and is known as application stage of mathematical theories.

3.2 The Visualization Learning Activity Model Based on Activity Theory

Experiments of visualization learning research were conducted in Guangzhou and Foshan, Guangdong province. Base on activity theory, it is found that visualization learning activity model includes five main activities called STILE model (as indicated in Fig. 2).

The five activities in STILE model includes:

(1) *Situation*: Create situation of exploratory thought via knowledge visualization, like micro-video, Learning Apps, digital learning tools and resources. Micro-video is kind of short video transform tacit knowledge to explicit one.
(2) *Thinking*: Students can use thinking visualization instruments to think and analyze problems.

(3) *Interaction*: students can take thinking visualization instrument as interactive platform to conduct exchange and interaction.
(4) *Lucubration*: Further deepen discussion and consolidate knowledge with different visualization methods.
(5) *Evaluation*: Obtain learning evaluation data. Reflect and evaluate learner's own learning with data visualization methods.

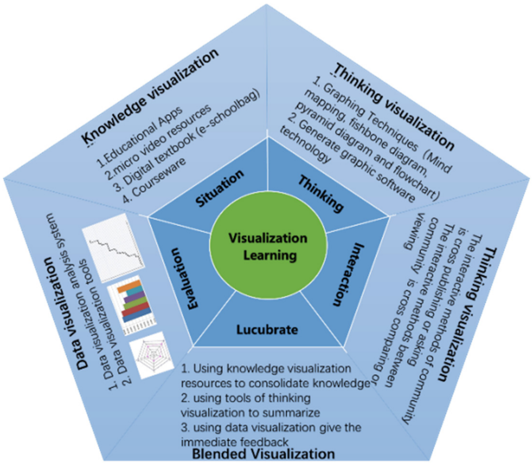

Fig. 2. The visualization learning activity model (STILE model)

3.3 Cultivation of Students' Learning Ability and Personalized Development are the Goals of Visualization Learning

Personalized education needs two necessary conditions – to shape the supporting condition as the foundation [26], and to take development of students' personalized learning ability as the objective. Teachers should recognize individual difference, giving full space for students to conduct independent activity and selection, and placing high value on cultivating students' learning ability and personal development [27]. Cultivation of personalized learning ability is the objective. Such ability mainly includes innovative thinking ability, independent learning ability and cooperative research ability [28]. Standards of Mathematic Curriculum of Compulsory Education (2011 version) proposed the need of cultivating students' mathematical thinking ability, ability of proposing problems and ability of solving problems in primary school stage [29].

Visualization learning of elementary mathematics aims to cultivate six kinds of ability: mathematical thinking ability, independent learning ability, cooperative exploration ability, ability of proposing problems, problem-solving ability and ability of getting and restructuring knowledge. So, the evaluation of research result is based on ability of the six aspects. On the basis of three-stage theory of mathematical learning activity proposed by mathematic educator Stolyar, the research added evaluation and reflection stage of learning effects for learning activity and process of mathematics and took mixture of activity theory and three-stage theory of mathematical learning activity as the foundation. In each stage, one or two learning activities among the five activity factors can be applied in designing activity. The five factors of visualization learning activity are mainly supported with knowledge visualization, thinking visualization and data visualization (as indicated in Fig. 3).

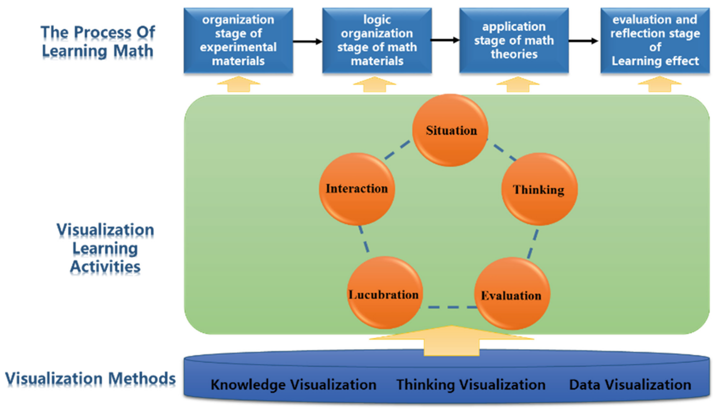

Fig. 3. Visualization learning scheme of elementary mathematics

4 Action Research on Visualization Learning of Mathematical Concepts

This research mainly adopted action research to study learning of mathematical concepts in Grade 4 Elementary Mathematics and selected 6 teaching contents on learning of geometrical concepts in two units: *Straight Line*, *Radial and Line Segment*, *Cognizing Angle*, *Classification of Angle*, *Vertical* and *Parallel*, *Parallelogram* and *Trapezoid*. Two rounds of action research were carried out on applying visualization learning methods in studying mathematics.

The first round of action research was carried out in class 4 of grade 4. Visualization learning methods of mathematics were applied and corresponding scheme of mathematical learning activity was designed. Problems in teaching process were analyzed and activity scheme was revised. The second round of action research was conducted in class 1 of grade 4 to further improve activity scheme of mathematical visualization learning and test learning effects of students.

4.1 First Round

4.1.1 Action

According to activity design method of researchers, teachers organized teaching activities in combination with teaching design and discussed problems in action research.

(1) Design of visualization learning process

With the class of *Straight Line*, *Radial* and *Line Segment* as the example, learning activities of six steps were designed. Firstly, students are asked to preview materials of textbook before class, and use visualization instrument to make summary before class. Secondly, teachers provide visualization resources, and create authentic living situation. Thirdly, visualization instrument is used. Fourthly, mutual correction of errors between groups is made, where teachers are asked to offer guidance and make revision. Fifthly, consolidation of exercise is made. After finishing them, the method of data visualization is used to ensure students to make clear the concepts that they have not mastered. Students are asked to analyze reasons of errors. Sixthly, students used visualization reflection to evaluate their own learning.

(2) Design of knowledge visualization resources

Teachers provide examples on straight line, radial and line segment in life, and design mathematical problems to be studied in class through the tablet PC.

(3) Selection of visualization instrument

For pre-class learning, students used pyramid diagram to learn summarizing ability among mathematical thinking abilities. For in-class learning, students used Venn Diagram to learn comparative analysis.

(4) Collection of data visualization materials (design of reflection and evaluation)

Reflection and evaluation are designed in combination of teaching objectives and ability objectives.

4.1.2 Observation and Reflection

By observing behaviors and performance of students in class, and analyzing the reflection, some problems in the learning process were found. Firstly, in pre-class preview step, students did not have visualization materials, but previewed textbook directly. By analyzing the pyramid diagram of thinking visualization, students were found not to well summarize the main features of straight line, radial and line segments. Secondly, visualization was not high and its logic was not strong. As a result, students cannot well understand the concepts of straight line, radial and line segments in the process of comparing concepts with visualization instrument. Thirdly, in deep exploration, students were active in studying interest-exploration problems and actively applied concepts to solve problems. However, as they spent more time on previous learning activity, students faced the problem of messed thinking in analyzing problems. Fourthly, students were found to be difficult to propose problems in filling in reflection and evaluation of visualization.

4.2 Second Round

4.2.1 Action

Targeted at problems appeared in the first round, design of visualization learning process and resources was adjusted in second round of action research process.

(1) Design of visualization learning process

The purpose is to promote the interpretation of visual representation. With the class of *Straight Line*, *Radial* and *Line Segment* as the example, the former teaching design was changed into "pre-class preview and initial thought – creation of situation and discussion of problems – group exchange, and thoughts and analysis – sharing works and breakthrough of difficult points – deep research and consolidating knowledge – reflection of learning, evaluation and feedback". Firstly, students are asked to learn knowledge visualization resources, and follows instructions to understand features of straight line, radial and line segment. Students still used the visualization instrument. Secondly, teachers directly propose mathematical problems to arouse learning interest without offering answers. By shaping authentic living situation with knowledge visualization resources, teachers provide micro video of knowledge visualization for the concepts. Thirdly, students still used the visualization instrument as the platform of group exchange, and think and analyze difference and similarities of the concepts. Fourthly, student took photos to uploaded their work. Students can review the work of other groups, and teachers can guide students to make correction. Fifthly, students were asked to use learnt concepts to solve problems. Teachers can offer timely feedback to explain the reasons of errors. Sixthly, students filled in the reflection and evaluation Table.

(2) Design of visualization resources

In order to improve defects of knowledge visualization resources in first round of action, teachers made animation of straight line, radial and line segments for pre-class review, and provided knowledge visualization resources used in class. Main contents were concerned about some straight lines, radials and line segments in real life. Some visualized and vivid videos were added to present features of radial and straight line. At the final part of video, visualization of the concepts' knowledge was presented and the corresponding problems were proposed.

4.2.2 Observation and Reflection

By observing behaviors and performance of students in class, and analyzing the reflection, it is found that students can make initial self-summary of concepts by watching more visual and specific animation during pre-class preview. In class, students were very interested in difficult interest-exploration problems of teachers and became more careful in watching and analyzing contents of micro video. Students can analyze problems in a shortened time period. In reflection and evaluation, students can propose their own problems.

5 Analysis on Effects

5.1 Test Performance of Geometrical Concepts of Mathematics of Students

We collected statistics on test performance of 41 students on geometrical concepts of mathematics of the same difficulty, before and after participating in action research. Pared-samples T test was conducted with IBM SPSS Statistics 19.0 to test learning effect of mathematical concepts. From Table 1, we can see difference significance probability p = 0 < 0.05, indicating obvious improvement of 41 students' mastery of geometrical concepts of mathematics after applying visualization learning methods.

Table 1. The pared-samples T test of performance of students.

	Pairing difference					t	df	Sig. (two sides)
	Average value	Standard deviation	Standard error of average value	95 % confidence level of difference				
				Lower limit	Upper limit			
First test – second test	−5.74390	6.95442	1.08610	−7.93899	−3.54882	−5.289	40	.000

5.2 Analysis on Data of Reflection and Evaluation Table

With research contents of Straight Line, Radial and Line Segment in the second round of action research as example, students filled in reflection table after learning them. Data of three boards in reflection table like knowledge acquisition, self-evaluation scale of ability and proposal of problem were analyzed as follows.

5.2.1 Acquisition of Concepts

In self-evaluation of students on knowledge acquisition, choice questions were adopted. 38 students selected completely correct answers and only three students made error, indicating students' basic mastery of mathematical concepts in this class: straight line, radial and line segment.

5.2.2 Ability Improvement

Students were asked to fill in self-evaluation of ability in reflection table. The scoring rate Fi of each ability dimension was indicated in Table 2. Data and practical result of the table showed scoring rate Fi of other items is higher than 0 except for the one less than 0.5 of the item that "you can flexibly apply knowledge learnt to solve mathematical problems of life", indicating that students need to further apply concepts to solve mathematical problems of life and improvement to students' mathematical thinking ability, independent learning ability, cooperative learning ability, problem-solving ability and ability of getting and restructuring knowledge.

In cultivating the ability of proposing problems, the students' reflection table was analyzed: 21 students among 41 students in class one of grade 4 proposed their own problems in reflection table, 11 students wished to understand the knowledge that they are interested in, and 9 students did not fill it in, indicating that some students have obtained the ability of proposing problems.

Table 2. The scoring rate Fi of each ability dimension.

Dimensions	Items	Fi Value
Mathematical thinking ability	1 In this class, you can use Venn Diagram to compare different concepts and pyramid diagram to make summary	0.62
	2 You can distinguish different straight lines, radials and line segments of life	0.84
Independent learning ability	1 You are willing to use thinking visualization instrument Pyramid diagram to preview concepts before class	0.57
	2 Your can use micro video, images and other learning materials provided by teachers to conduct independent learning	0.72
Cooperative research ability	1 You are wiling to listen to suggestions and views of classmates and actively exchange ideas with classmates in group activity	0.71
	2 In participating in activities of group exploration, you can solve problems proposed by teachers together with other classmates and learn new knowledge	0.76
Problem-solving ability	1 You can flexibly apply knowledge learnt to solve some mathematical problems of life	0.48
	2 You can use thinking visualization instruments (fishbone diagram, Venn Diagram and mind map) to solve mathematical problems	0.59
Ability of getting and restructuring knowledge	1 You are willing to use thinking visualization instruments to express your understanding on mathematical concepts in learning process	0.56
	2 You can get mathematical knowledge in the process of watching micro video, or using visualization mathematical instruments or software	0.68

6 Conclusion

This paper proposed five kinds of learning activities supported with visualization methods, and applied them in two rounds of action researches in learning geometrical concepts of elementary mathematics. The result showed that, in learning process of geometrical concepts of elementary mathematics, knowledge visualization, thinking visualization and data visualization of pre-class and in-class can support five learning activities: creation of situation, thought and analysis, group exchange, deep research, and evaluation and reflection. They effectively drive students to master geometrical concepts of elementary mathematics, and gradually improve abilities of students like mathematical thinking ability, independent learning ability, cooperative research ability, problem-solving ability, ability of obtaining and restructuring knowledge and ability of proposing problems. Some problems are still unresolved. For example, the application of concepts by students to solve real life mathematical problems needs to be further improved. It is believed that the learning activities can be enriched with more life problems for learning the concepts of elementary mathematics.

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The Augmented Hybrid Graph Framework for Multi-level E-Learning Applications

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Abstract. The advances in MOOCs, Web learning communities, social media platforms and mobile learning apps have been witnessed in recent few years. With the development of these applications and systems, the significant growth of learning resources with multimodalities (e.g., web pages, e-books, lecture videos) has greatly changed the way people learn new knowledge and skills. However, this results in the problem of information overload as learners are overwhelmed by the rich learning resources that accompany the ever developing technologies. In other words, it is increasingly difficult for learners to find required learning materials efficiently and effectively when they confront such a large volume of data. To tackle this problem, it is essential to build a powerful framework to organize e-learning resources and capture learning preferences. In this paper, we therefore propose a graph-based framework to achieve these intended outcomes by integrating various hidden relationships among learners, users and resources. Throughout the case studies, we have verified that the proposed framework is very flexible and powerful to support various kinds of e-learning applications in different scales.

Keywords: Graph-based model · E-learning systems · Learning preferences · Hidden relationship · Conceptual framework

1 Introduction

The advances in MOOCs, Web learning communities, social media platforms and mobile learning apps have been witnessed in recent years. With the development of these applications and systems, the significant growth of learning resources with multimodalities (e.g., web pages, e-books, lecture videos) has greatly changed the way people learn new knowledge and skills. For example, it is common that learners may load and watch a short course video via mobile phones on their way home.

However, this result in the problem of information overload as learners are overwhelmed by the rich learning resources that accompany the ever developing

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technologies. In other words, it is increasingly difficult for learners to find their required learning materials efficiently and effectively when they confront such a large volume of learning data. To tackle this problem, we propose a graph-based framework by mainly considering the following characteristics.

- **Multi-relational.** The relationships among users, knowledge units and learning resources are very complicated. In addition to the typical relationships among them (i.e., a user has learnt some knowledge units from a learning resource), there are many useful hidden relations that need to be identified. For example, the pre-requisite relations among knowledge units or social relations among users are paramount for various applications.
- **Multi-modal**. There are various kinds of learning resources with multiple modalities in the Web. Materials like lecture videos, e-books, web pages, animations or even mixed types of these objects are widely adopted in the e-learning systems. It is indispensable to encompass various kinds of resources in a unified framework.
- **User-oriented**. The user learning intentions and preferences are subjective and context-dependent. It is essential to understand personal perceptions and preferences of diverse users in e-learning systems. Therefore, the learning resources can be organized from a user-oriented perspective and personalized learning services can be supported.

Motivated by these observations, we propose a unified framework based on the augmented hybrid graph (AHG) [1] to take the above characteristics into consideration in this article. Furthermore, the learning preferences are modeled and captured by the learner profiles [2, 3]. By integrating with a context model, the proposed framework can support heterogeneous e-learning applications in different scales.

The remaining parts of this paper are structured as follows. Section 2 reviews some related research on e-learning systems. In Sect. 3, we introduce the proposed framework including the augmented hybrid graph, the learner profile and the context model. Section 4 illustrates how to support and facilitate various e-learning applications through the proposed framework. Finally, we conclude our research and suggest possible directions for the future work in Sect. 5.

2 Related Work

Recently, the rapid development of Massive Online Open Course (MOOC) has attracted wide attention in e-learning research community. There are mainly two streams of work in this area. One of them focuses on learning resources (resource-centered), presenting them in diverse ways to improve the learning efficiency. A typical example for this category of research is game-based learning, which offers a relaxing way for learners to enhance their achievement as well as the learning motivation. In [4], the concept of flow was employed in an e-learning game called 'Frequency 1550' to investigate the student engagement and possible learning effects. To expand the potential of competition models in game-based learning, Chen and Chen [5] proposed the notion of surrogate competition, which eliminated direct competitions among students so that the competitions between students are more relaxing.

Another approach to modeling and validating the interactive scenarios for serious e-learning games was proposed in [6]. In [7], Fu et al. developed a more rigorous scale to assess user enjoyment of e-learning games based on the GameFlow, which was a model for evaluating player enjoyment in games devised by Sweetser and Wyeth [8]. Another common application is the pedagogical agent, which is a virtual computer tutor who assists students (or learners) in their various learning tasks. An animated pedagogical agent, named Steve, was designed by Johnson and Rickel [9] for procedural training with the use of virtual reality techniques. Moreover, Choi and Clark [10] investigated the use of an animated pedagogical agent with different paradigms in a multimedia learning environment for learning English as a Second Language (ESL), and found that the pedagogical agent was helpful if the appropriate instructional methods were selected. In [11], Lane et al. presented the Coach Mike, an animated pedagogical agent for computer science education, which incorporated the self-regulatory feedback mechanism with learners and enhanced the efficacy of the system.

The other stream of work mainly concerns about the learner side (user-centered) while creating personalized learning experience and supporting individual learning environment. Lu [12] proposed a multi-attribute evaluation method to model student needs and fuzzy matching methods to facilitate the personalized learning material recommendations. In [13], Chen et al. considered user individual learning abilities and course difficulties based on the Item Response Theory (IRT) to discover the personalized learning path. To automatically adapt to learner interests and knowledge levels, Klašnja et al. [14] presented an intelligent tutoring system called Protus to recognize different patterns of learning styles and learner habits through testing their learning styles and mining their server logs. Romero et al. [15] developed a specific web mining tool and applied the user web usage patterns for personalized hyperlinks in adaptive educational systems. Moreover, Zhao and Forouraghi [16] modeled user performance feedback and enhanced the MOODLE (Modular Object-Oriented Dynamic Learning Environment) by developing two new modules, which were the virtual lab module (VLM) and the study progress module (SPM) for cloud-based virtual learning environment.

3 The Proposed Framework

In this section, we will present the unified framework based on the augmented hybrid graph (AHG). Specifically speaking, the framework includes three components: the augmented hybrid graph (AHG), the enriched learner profile and the context model. The context model is adapted from other research [17], and the other two components are the core of the graph-based framework. These components will be presented in the following subsections respectively.

3.1 Augmented Hybrid Graph

Essentially speaking, the AHG is a graph-based framework that integrates multiple information sources and their diverse relationships such as the social relations, pre-requisite relations and content relations.

The typical graph-based model in e-learning system is the learner tripartite graph (LTG) which captures the relationships among learners, (learning) resources and knowledge units as illustrated in Fig. 1. Generally, the LTG is a directed graph, which is formally defined as:

$$G = (V, E); V = L \cup R \cup U; E = E_{l \leftrightarrow r} \cup E_{r \leftrightarrow u} \cup E_{l \leftrightarrow u} \tag{1}$$

where vertex set V contains learner vertex set L, learning resource vertex set R, and knowledge unit vertex set U. The edge set E represents the relationships among these sets (e.g., learner l_{A} acquires knowledge unit u_{a} and u_{b} via resource r_{a} as shown in Fig. 1).

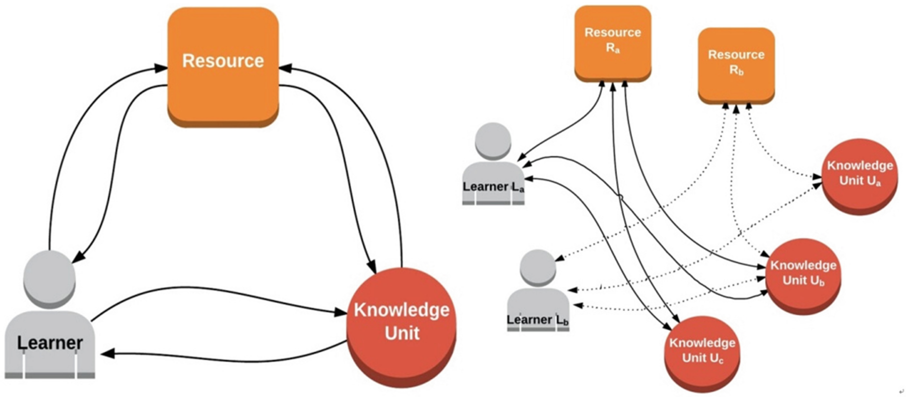

Fig. 1. The paradigm and an example of the learner tripartite graph (LTG)

Note that $E_{l \leftrightarrow r}$ here includes two edge sets, which are the set of edges from learners to resources ($E_{l \to r}$) and vice versa ($E_{l \leftarrow r}$). In other words, edge set $E_{l \leftrightarrow r}$ can be further divided into two subsets according to the edge directions, i.e., $E_{l \leftrightarrow r} = E_{l \to r} \cup E_{l \leftarrow r}$, which can be similarly applied to $E_{r \leftrightarrow u}$ and $E_{l \leftrightarrow u}$.

To further integrate other kinds of relations like learner social relations, resource content relations and knowledge pre-requisite relations, three affinity sub-graphs are built based on their intra-similarities (e.g., the learner social similarity) as shown in Fig. 2.

Firstly, the learner affinity subgraph can be constructed using the learner social similarity, one of which can be measured by their common social ties [18] in the system as follows:

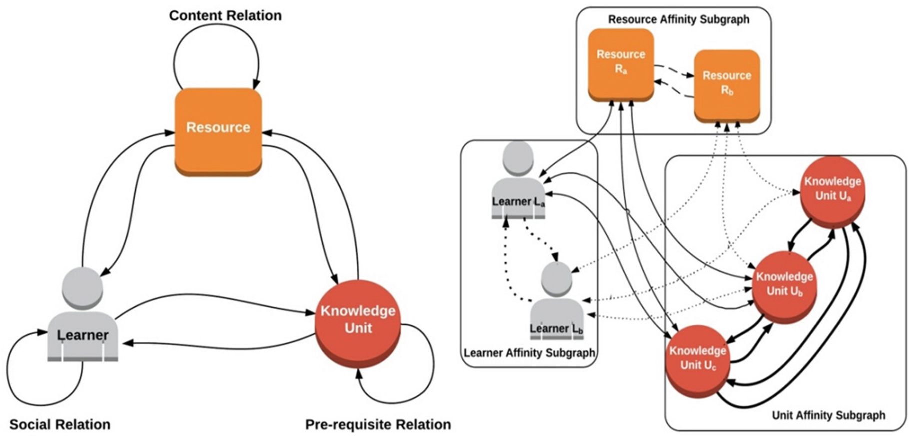

Fig. 2. The paradigm and an example of the augmented hybrid graph (AHG)

$$Sim_L(l_a, l_b) = \frac{n(l_a, l_b)}{n(l_a) + n(l_b)} \tag{2}$$

where $n(l_a)$ and $n(l_b)$ are the numbers of social ties of learner l_a and l_b respectively, $n(l_a, l_b)$ is the number of their common social ties. The assumption behind this measurement is that two learners are more similar when they have more common social connections.

Secondly, the resource affinity subgraph can be constructed using their content-based similarities. There are various modalities of learning resources (e.g., documents, slides and videos) in e-learning systems. Take slides (including words and images) as an example. We can adopt the global feature-based method [19] to extract image features (e.g., color correlogram, color histogram, wavelet texture) and a bag-of-words to model word features. Thus, the resource content can be represented by vector space model (VSM), and the similarity can be measured by their cosine similarity:

$$Sim_R(r_a, r_b) = \frac{\vec{r}_a \cdot \vec{r}_b}{|\vec{r}_a| \times |\vec{r}_b|} \tag{3}$$

where $\vec{r}_a$ and $\vec{r}_b$ are the feature vectors of resource r_a and r_b respectively.

Thirdly, the unit affinity graph can be built based on the distance (similarity) of two knowledge units in the Dynamic Concept Network (DCN) proposed by Leung and Li [20], where the knowledge units (concepts) are the vertices and the pre-requisite relationships are the edges. As shown in Fig. 3, the similarity of two knowledge units can be measured by the sum of their distances to the nearest common ancestor node in DCN. Formally, the similarity of two knowledge units is defined by the inverse of the distance in the DCN.

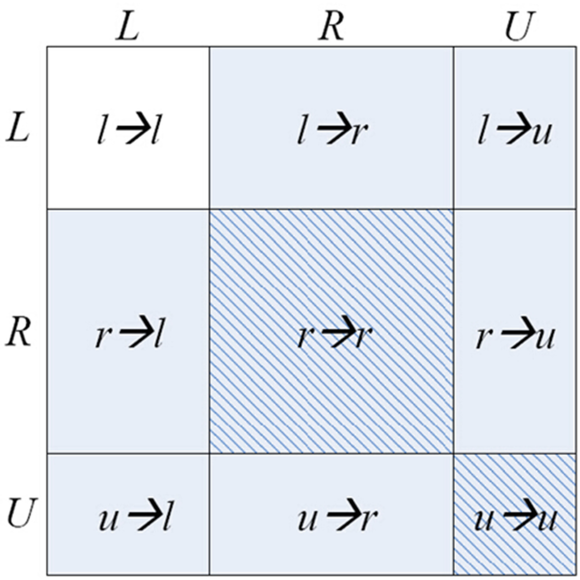

Fig. 3. The illustration of transition matrix

$$Sim_U(u_a, u_b) = \frac{1}{1 + |2u_{ab} - u_a - u_b|_{DCN}} \tag{4}$$

where u_{ab} is the nearest common ancestor node for u_a and u_b, $|2u_{ab} - u_a - u_b|_{DCN}$ is the sum of their distances.

By integrating the above three affinity subgraphs with LTG, we can obtain the augmented hybrid graph (AHG) as illustrated in Fig. 2. Formally, AHG is defined as:

$$G' = \left(V', E'\right); V' = V; E' = E \cup E_{l\leftrightarrow l} \cup E_{r\leftrightarrow r} \cup E_{u\leftrightarrow u} \tag{5}$$

where V' is the same vertex set as given in LTG, E' is the edge set by extending edge set E with edges in learner affinity subgraph ($E_{l\leftrightarrow l}$), resource affinity subgraph ($E_{r\leftrightarrow r}$), and unit affinity subgraph ($E_{u\leftrightarrow u}$). For the weight of edges, they can be calculated by Eqs. (2), (3) and (4), respectively.

3.2 Enriched Learner Profile

In e-learning systems, the learner profile, which can be depicted by social friends, interesting resources and the corresponding knowledge units, is represented as a triplet:

$$\vec{l_i} = (L_i, R_i, U_i) \tag{6}$$

where L_i is the set of learners who have social ties with learner i, R_i is the set of resources learned (interested) by the learner, and U_i is the corresponding knowledge units acquired by the learner via the resources. To build a more powerful learner profile and tackle the sparsity problem, the vertices (including learners, resources and knowledge units) with the nearest distance are good candidates for user profile enrichment. Since there are various relations in AHG, we adopt the random walk model [21], which has been extensively studied and widely used in graph-based applications (e.g., social networks). Instead of using other graph-based metrics (e.g., the number of hops or the shortest path), we use random walk as a measurement because it is a very suitable distance proximity between two vertices with multiple paths in a directed graph.

By including all probabilities of reaching one vertex from another through their multiple paths, the random walk can unify various kinds of relations between them. To apply the random walk in AHG, the transition probability matrix P for AHG is defined as a square matrix ($m \times m$, where m = |L| + |R| + |U|). As shown in Fig. 3, matrix P can be further divided into nine sub-matrices, one of which denotes a kind of edges (e.g., $l \rightarrow r$ denotes those edges from a learner vertex to a resource vertex). The random walk then can be applied to graphs by employing the parameter α as 'random jump', and the transition probability matrix is further updated by:

$$P'_{l+1|l}(j|i) = (1-\alpha)P_{l+1|l}(j|i) + \alpha G \tag{7}$$

where $P_{l+1|l}(j|i)$ is the transition probability matrix as illustrated in Fig. 3, where the entries denote the weight of the edge from vertex i to j, G is m $\times$ m matrix of which all entries be set to a unified value (e.g., $1/\text{n}$) as we assume that these values are uniformly stochastic distributed.

To select the candidate vertices for learner profile enrichment, we can rank the candidates based on the total random walk probabilities for reaching all vertices (as defined in (6)) in the learner profile by.

$$R\text{-}Score\left(v, \vec{l_i}\right) = \sum\nolimits_{l \in L_i} p'(v|i) + \sum\nolimits_{r \in R_i} p'(v|r) + \sum\nolimits_{u \in U_i} p'(v|u) \tag{8}$$

where *R-Score* is the total random walk probabilities from an abstract vertex v (could be a learner, a resource or a unit vertex) for reaching all learner vertices ($l \in L_i$), resource vertices ($r \in R_i$) and unit vertices ($u \in U_i$) in the learner profile. Thus, the top-N candidate vertices can be selected according to *R-Score*. To distinguish the enriched learner profile from the original one, we use $\vec{l_i}\,'$ to denote the enriched learner profile as:

$$\vec{l_i}\,' = (L'_i, R'_i, U'_i) \tag{9}$$

where $L'_i = L_i \cup L_v$, $R'_i = R_i \cup R_v$, $U'_i = U_i \cup U_v$, and L_v, R_v, U_v are learner, resources and unit vertices that are selected based on *R-Score* to achieve the profile enriching purpose.

3.3 Context Model

The context model for a learner in e-learning systems has been discussed in our earlier work [17]. Formally, the context in three levels (i.e., the personal context, group context and class context) for a learner i can be defined as follows:

$$PC_a^i = (c_1 : w_{1,a}^i; c_2 : w_{2,a}^i \ldots c_n : w_{n,a}^i) \tag{10}$$

$$GC_a^k = (c_1^{'} : w_{1,a}^k; c_2^{'} : w_{2,a}^k \ldots c_m^{'} : w_{m,a}^k) \bigcup_{i \in k} PC_a^i \tag{11}$$

$$DC_a^x = (c_1^* : w_{1,a}^x; c_2^* : w_{2,a}^x \ldots c_q^* : w_{q,a}^x) \bigcup_{k \in x} GC_a^k \tag{12}$$

where $c_1, c_2, \ldots c_n$ are the contextual attributes included in the context modeling, $w_{1,a}^i, w_{2,a}^i \ldots w_{n,a}^i$ are the corresponding contextual values for the attributes (e.g., the contextual value 'rain' for the attribute 'weather') for learner i under individual context a; $c_1^{'}, c_2^{'}, \ldots c_m^{'}$ are the contextual attributes only at the group level, $w_{1,a}^k, w_{2,a}^k \ldots w_{n,a}^k$ are the contextual values for these attributes (e.g., the contextual value 'project' for the attribute 'task'), $\bigcup_{l_i \in k} PC_a^i$ is the union set of all group members' personal contexts; $c_1^*, c_2^*, \ldots c_q^*$ are the unique contextual attributes at the class level, $w_{1,a}^x, w_{2,a}^x \ldots w_{n,a}^x$ are the contextual values, and $\bigcup_{k \in x} GC_a^k$ is the union set of all group contexts in the class [17].

4 Supporting Heterogeneous E-Learning Applications

In this section, we illustrate how to adopt the proposed framework to support heterogeneous e-learning applications at various levels. In particular, personalized resource recommendation, group member discovery and class contents pruning are introduced.

- **Personalized Courseware (Resource) Recommendation**: Fig. 4 illustrates the process of personalized resource recommendation. Firstly, a contextualized learner profile is obtained by identifying relevant parts of a learner profile in a personal context (a.k.a., "contextualization") via some association rule mining techniques such as Apriori or FP-growth algorithms. Then, we discover the nearest resources to those vertices in the contextualized learner profile in the AHG. Finally, a set of resources are ranked based on some metrics (e.g., the sum of distances to all vertices in the contextualized learner profile) and recommended to the learner.
- **Group Member Discovery:** Fig. 5 shows the main procedures of discovering a suitable member for a specific group. Since there are some members (rather than a single learner) in a group, the learner profiles of all members should be considered during the contextualization. The contextual aggregating learner profile (or called "contextualized group profile") is firstly constructed by aggregating the learner profiles of all members, and then contextualized by the group context. Similarly, the nearest learners are identified to those vertices in the contextualized group profile. Lastly, they are ranked by the distance measurement and listed as group member candidates.

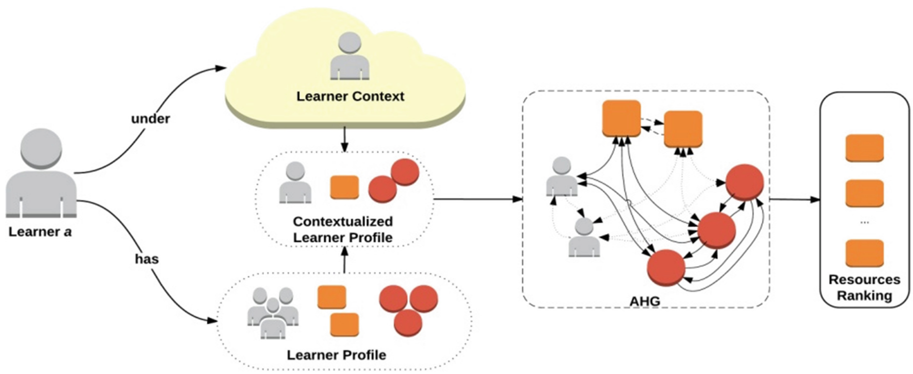

Fig. 4. The illustration of context-aware personalized courseware (resource) recommendation

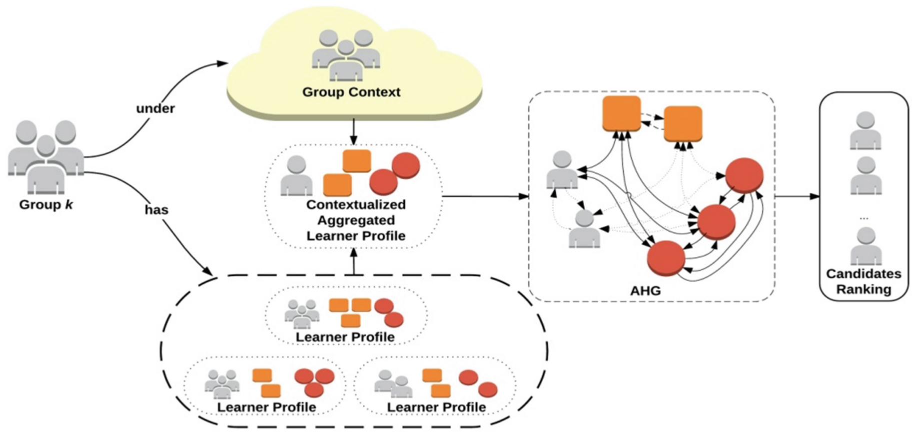

Fig. 5. The illustration of context-aware group member discovery

- **Class Content Pruning (or Augmentation):** As shown in Fig. 6, the framework of class content pruning consists of three steps. Similar to the above group-level application, the learner profiles in the class will be aggregated and contextualized by the current class context. By making use of the aggregated contextual learner profiles of the class (or called class profile), we further consider the set of knowledge unit vertices in the class profile (or the nearest knowledge unit vertices) as the pruning candidates as these knowledge units have been already familiarized or mastered by learners in the class. Next, the class content, which is structured by the knowledge unit network, can be compared with this candidate set (e.g., see whether they co-occur in the set and class content) and ranked the final candidates for content pruning.

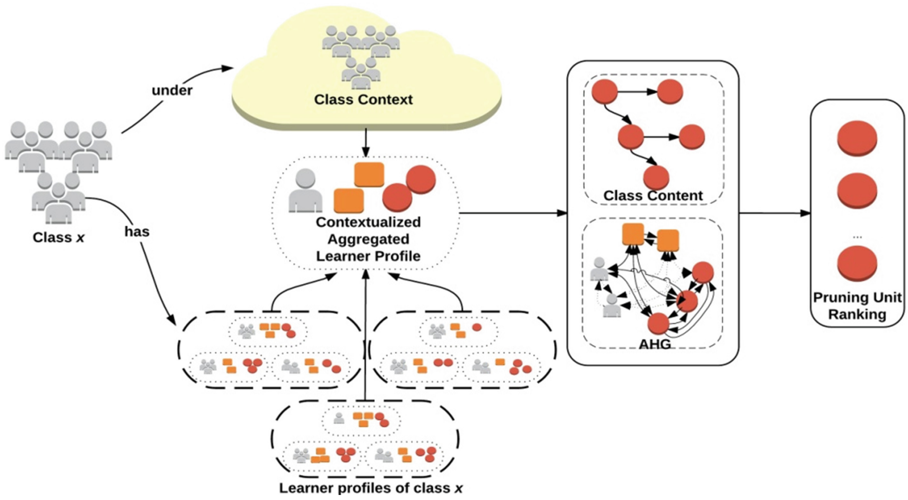

Fig. 6. The illustration of context-aware class content pruning

5 Conclusion

In this article, we propose the AHG-based framework together with the enriched learner profile and the context model to support the heterogeneous applications in different scales. The proposed framework mainly takes the multi-relational, multi-modal and user-oriented features in the e-learning system domain into consideration. Furthermore, we illustrate how to exploit the proposed framework to support personalized resource recommendation, group member discovery and class content pruning. In the future, we plan to conduct user studies on these applications, so that the effectiveness of the proposed framework can be further validated.

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Research on Approach of Improving Teaching Quality and Promoting Equity by the Integration of Information Technology and Subject Teaching

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Abstract. Based on the common misunderstandings and connotation of educational informationization as well as the value appeal of education reform, this paper puts forward the basic idea of innovative teaching, and promotes education fairness by the integration of information technology and subject teaching. Specific ways and methods are proposed. Evaluation is conducted, and the effectiveness of a digital learning environment is analyzed.

Keywords: Innovative teaching · Subject teaching · Digital learning environment

1 Introduction

Education is essential to the new generation. However, our education neither fit the national development of economy and society nor meet the requirements for people to receive education. This is because of the old education concepts and contents. Deepening the education reform, improving education quality, and promoting fairness are the common goals for the whole society.

The National Education Plan for Medium and Long term Development and Reform (2010–2020) indicated that information technology has revolutionary influence, and should be paid high attention. One emphasis is to promote education innovation by information technology and to modernize education by educational informationization. It explicates the specific task in tactic in both micro and macro aspects. However, how to proceed educational informationization, and what kind of problems to be solved? There are many ideas and opinions. This paper shared the author's experience in promoting innovate teaching and education fairness by the integration of information technology and subject teaching.

2 Educational Informationization

There are a number of common misunderstandings of educational informationization.

a. Many education administrators believe that resource is the key factor to achieve educational informationization.

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b. Many people believe using the courseware or online resource from the text books can achieve educational informationization.
c. Many leaders consider that educational informationization is the matter of technologist.
d. Informationization aims to improve working efficiency.
e. Many people believe that once the informationization environment is built, if it can't be used well, there will be the problems of the teachers.
f. Many people believe that digital teaching mainly includes web portals and management system. This is wrong, as the core of digital teaching include teaching resources, teaching system and learning system.

Educational informationization is concerned about using information technology to support teaching, improve quality and promote fairness. The focus should be on the teaching methods. The primary aim of educational informationization is to reform education and reform learning.

3 The Value APPEAL of the Education Reform

The Core Issue of Education. The biggest problem of education is that the students think the knowledge taught by teaches is useless, and they do not agree with the learning content. On the other side, many teachers always think how to teach the students, instead of thinking from the angle of the students. Students were taught blindly, lacking creativity and purpose.

With the support of information technology, the teaching process and environment can be optimized. The core feature of creative thinking ability is to discover the problem, conceive the knowledge which can solve it. Students need to experience, and go through the thinking process of induction, choice and evaluation. With the creative thinking ability, a student has the confidence and motivation to learn.

Schools usually pay more attention to the education result. The learning process of students is blindly accepted and painful. The students have no chance to go through the process of discovery and induction. How can they develop the creative thinking ability? This is the core issue of education.

The Goal and Way of Education Reform. It is necessary to make the students consider that learning knowledge is useful. Learning should be personalized, according to the knowledge level, cognitive level and interests.

From the perspective of learning goals, education reform is to make students realize that the subject taught which can solve the real life problems. Currently, many the teachers teach knowledge from the start, and then explain the details. This should be changed to help students to develop the ability to form solutions to solve problems which they are interested in.

Figure 1 shows the learning goal reform. The aim is to help students develop the independent learning ability and innovative thinking ability.

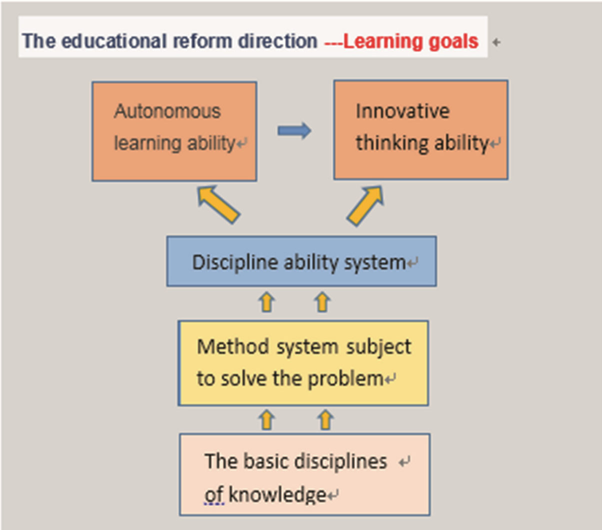

Fig. 1. Learning goals reform

4 Promoting Innovative Teaching and Education Fairness

One direction of education reform is smart education. From the objective perspective, students can form the discipline system, develop the independent learning ability and innovative thinking ability, and become smarter. They can learn actively, relaxed and happily. Teachers should teach wisely in order to help the students choose a suitable way of learning in accordance with their own cognitive level, knowledge level, interests and hobbies, and to provide students with effective learning resources.

The basic ideas can be summarized as follows:

a. To identify the essential problems of education;
b. To explore new ideas to solve these essential problems;
c. To analyze how to use information technology; Based on the new educational idea, to analyze what cannot be achieved under the normal situation, whether the information technology can support, what kind of teaching environment should be provided?
d. To find out way to improve the education fairness.

5 Integration of Information Technology and Subject Teaching

The integration of information technology and teaching aims to develop a model of innovative teaching and smart education. It is more important to let students explore the knowledge, and enhance the ability of innovative thinking and independent learning ability. There are five objectives of the education model. First, students should take the initiative to study. Second, students can personalized learn. Third, students can think in creative and intelligent ways. Fourth, students can learn easily and happily. Fifth, students can dynamically determine their learning direction.

Active Learning. Let the student learn actively. The teachers should deduce the knowledge from the real life problems and tasks. They design problems and tasks, which match the students' cognitive level and knowledge level. Problems and tasks should be coherent for a piece of knowledge. For example, the "tree planting problem" in primary school mathematics aims to teach mathematical interval. We should set out questions in order to track the students to find solutions. Learning can be deepened. Students should be provided with a environment supported by information technology.

Personalized Learning. Students should be asked to solve problems and tasks according to their knowledge level and cognitive level. The purpose is to let them find the right way to learn. They should be provided with effective learning tools and resources. Information technology can be used for constructing the personalized learning environment.

Creative Thinking and Smart Learning. Students should be cultivated to acquire knowledge through exploration. Information technology can be used to construct a learning environment conducive to creative thinking and smart learning. The teachers provide the necessary information for the students to construct the knowledge. A question database is built. In these questions, students are asked to solve problems. Through an exploration process, they can acquire the knowledge required for solving the problems.

Relaxed and Happy Learning. It is desirable that students can be provided an environment for learning in a relaxed and happy atmosphere. Information technology can be applied to build such a learning environment.

Determine the Direction of Learning. Useful data are collected during the learning process. Through the big data analysis, the students' strong and weak areas can be identified. An appropriate study plan can be derived accordingly. Information technology can be effectively used for recording the students' learning characteristics, and helping the teacher identify the students' strong and weak areas.

In summary, the purposes of reforming the teaching model are to make the students willing to learn, to help them gain new knowledge and convert the learned knowledge to skills, and at the same time, to enhance their ability of independent learning and innovative thinking, and to help students to make personalized adjustment for learning. All these need the support of information technology.

Methods to Achieve the Revolutionary Integration. Balanced development with school is the starting point. It's our pursuit to make all students enjoy learning. Good teaching plans, teaching resources and software should be shared among teachers. The good practices should be accompanied with guidance from the subject expects and the support of information technology. However, these are difficult to achieve. Good practices need to integrate the wisdom of different experts. There are a number of key success factors. There should be a strong team of subject specialists and information technology experts.

Government should provide management support. Teachers can work together to develop teaching resources and software. From time to time, evaluation should be undertaken to improve the teaching practices. Figure 2 outlines these essential components.

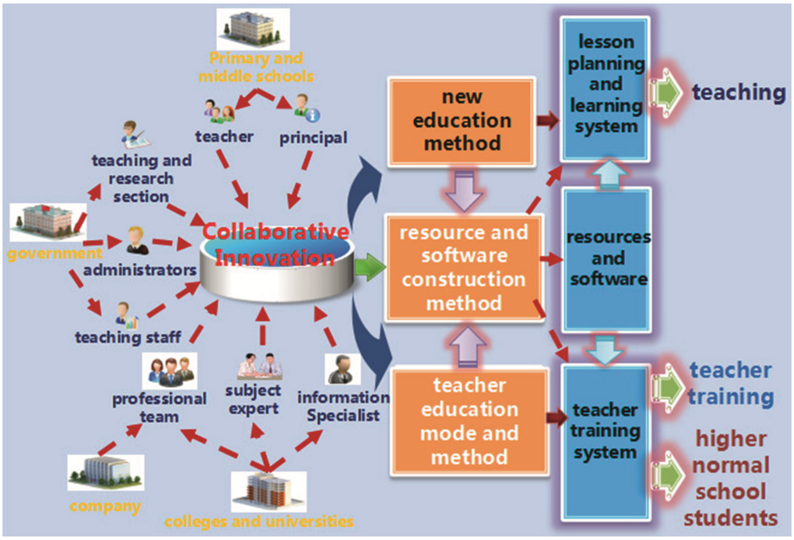

Fig. 2. The ways and methods of balanced development

6 Digital Environment for the Realization of Integration

To realize the integration of information technology and subject teacher, we need to develop a digital environment for teachers to prepare teaching resources. Multimedia and interacting learning elements should be supported. Training should be provided to the teacher in preparing the teaching resources. The environment should allow sharing of teaching resources among teachers.

The infrastructure for this digital environment has several components, including a digital campus platform, an education cloud and network learning space, a teaching resources construction system, a lesson preparation system, a teaching evaluation system, a teacher training system, and a smart classroom.

Digital Campus Platform. Digital campus platform provides a series of functions to support teaching, as shown in Fig. 3. These functions include the preparation of resources, classroom teaching, examination and marking and quality assurance. System administration and security features should be provided. The platform can monitor the students' learning progress, and help students to define learning plan to achieve the learning objectives. It should support personalized learning. Finally, the platform should be simple to understand, and easy to use.

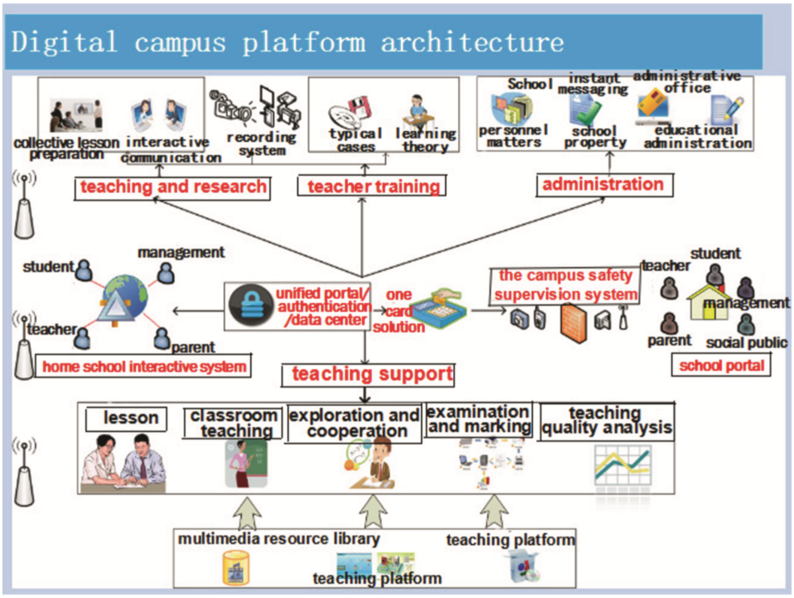

Fig. 3. Digital campus platform architecture

Education Cloud Platform and Network Learning Space. Education cloud platform at all levels (national education cloud, provincial education cloud, municipal education cloud, and district education cloud) provides a variety of network resources for schools. These resources can be used in the construction of the digital campus and individual learning spaces to support teaching, learning, research and management.

Teaching Resources Construction System. The teaching resources construction system is difficult to build. The system provides guidance for preparing and organizing teaching resources such as video lecture, case study, etc. The system should provide an effective classification scheme for these teaching resources as well as search mechanism for teachers to find useful and relevant teaching resources. The system should also provide functions for sharing of teaching resources.

Lesson Preparation System. The system helps the teachers prepare lessons with the teaching resources. Tools are provided for the teachers to integrate relevant teaching resources which can be slides, animation, videos, etc. Word and Powerpoint files are supported. The prepared lessons can be hosted on the cloud platform for convenience in sharing and use. Figure 4 outlines the lesson preparation system.

Interactive Teaching Evaluation System. An interactive teaching evaluation system provides useful data analysis on the students' learning characteristics, strong and weak

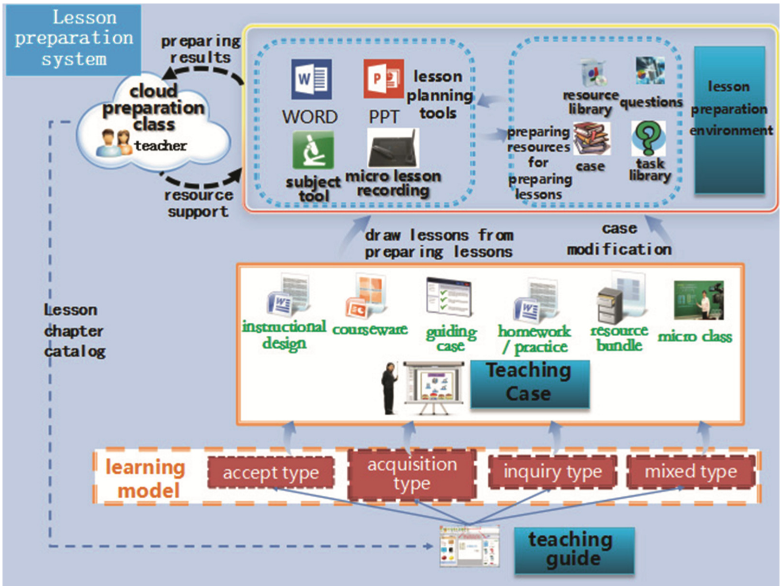

Fig. 4. Lesson preparation system

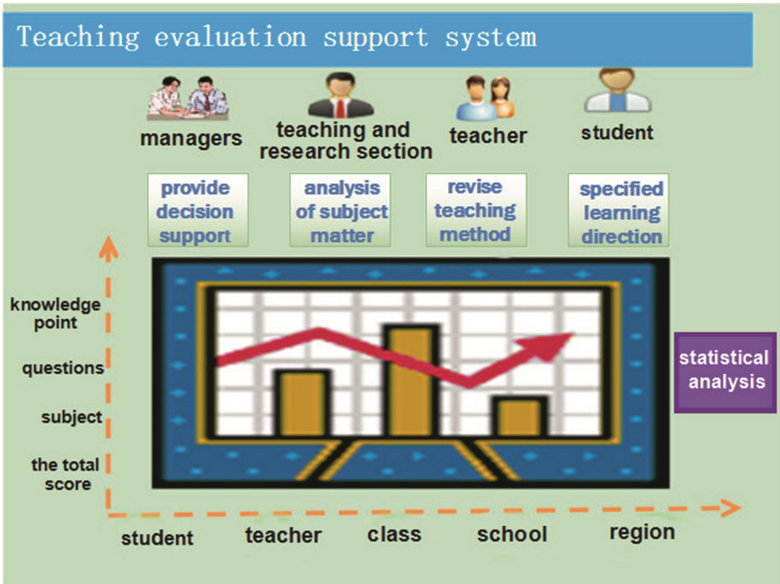

Fig. 5. Interactive teaching and evaluation system

areas. The analysis help the teacher review the teaching method. It also help the management to make decision making. Through the evaluation, the teaching quality can be enhanced. Figure 5 outline the teaching evaluation system.

Teacher Training System. Teachers need to use a variety of tools, such as video recording software, authoring tool, simulation software, etc. A teacher training system is provided to facilitate training for these software and tools. The system should also provide a platform for knowledge exchange among the teachers.

Smart Classroom. A smart classroom is equipped with an education cloud platform and individual network learning space. Audio and video equipment are provided. Classroom lectures and group learning activities can be recorded. The recorded lectures and recorded learning activities can be broadcasted for sharing, review and evaluation. These are especially useful for team learning.

7 Conclusion

We should have a correct understanding of the goal of education informationization. It aims to build a new learning environment with revolutionary changes.

The application of information technology is to support the implementation of new ideas and methods of education. It should provide a learning environment according with the needs of educational innovation. This requires the cooperation of two teams of experts, namely, information technology experts and education researchers. Besides, there should be policies to promote educational innovation, for example, incentive and reward mechanisms.

Information technology should be applied in the teaching and learning process, including lesson preparation, teaching, evaluation and adjustment. According to the learning needs, appropriate learning environment is provided. Teachers are encouraged to develop and share learning resources. Good practices should be established. Three aspects of support are required, namely, technical support on the learning environment, training support on teaching practices, and management support on monitoring and evaluation. The ultimate goal is to help students develop innovative thinking ability and independent learning ability.

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Application of VR Glasses in Blended Classroom Teaching with the Combination of Virtual and Real Worlds

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Abstract. Virtual reality (VR) has become a mature technology, and gradually applied to teaching and learning. This paper investigates the application of VR glasses in a blended classroom teaching environment where the virtual and real worlds are combined. The impacts to the traditional classroom teaching are observed, and the teaching effectiveness is evaluated. The prospect of this application is discussed.

Keywords: VR glasses · Virtual reality · Blended learning

1 Introduction

The emergence of virtual reality (VR) technology has been present for 60 years. But only in the recent 20 years, the technology has become well known and widely used. At present, a new batch of virtual reality technology products has appeared. VR glass is a good example. We only need a pair of glasses to visualize the virtual world. This paper investigates the application of VR glasses in the blended classroom teaching environment.

Blended teaching brings the students to a new learning environment different from the traditional classroom teaching. It refers to the application of appropriate learning technologies together with appropriate learning styles to achieve optimal learning effectiveness [1]. This paper aims to promote the combination of virtual and real worlds of teaching, so as to enrich the students' learning experience and to address the students' different learning needs.

2 VR Technology for Blended Learning

VR has evolved in a very fast pace in the recent 20 years. Along with the rapid development of the VR technology, many VR devices have been produced. These VR devices can be divided into three categories, namely, external-wearing devices, one-piece head devices, and mobile-end devices.

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2.1 VR Devices

Typical external-wearing devices are VR headsets with connection to the PC or host computer. External-wearing devices have independent screens. The product structure is more complex and sophisticated, with more high-end technology contents [2]. However, under the yoke of the connection cables, the users cannot freely move. Examples are HTC vive and Oculus Rift.

Different from the external-wearing devices, one-piece head devices do not have any connection to external devices such as PC or host computer. These devices are also called VR all-in-one device. Without any connected wire, the users have better experience in terms of visual impact and 3D stereo-feeling.

Mobile-end devices adopt a simple structure. They are operating together with the mobile phones. Mobile-end devices are easy to operate and carry. Another advantage is that the costs of these devices are low as compared to the external-wearing devices and one-piece head devices or all-in-one devices. A typical form of mobile-end devices is the VR glasses [3].

VR glasses involve the application of simulation technology, computer graphics, man-machine interface technology, sensing technology, and network technology. The latest VR glasses adopt a folding glass design. With a lighter weight, it has a smaller size and is easy to carry.

2.2 VR Glasses

Oculus Rift DK2, SONY Project Morpheus, samsung Gear VR are currently the popular VR glasses devices worldwide, as shown in Fig. 1. Some domestic VR glasses are also evolving, such as the small Xiao zhai Z series and the LeTV Cool 1, as shown in Fig. 2.

Fig. 1. Some popular VR glasses (worldwide).

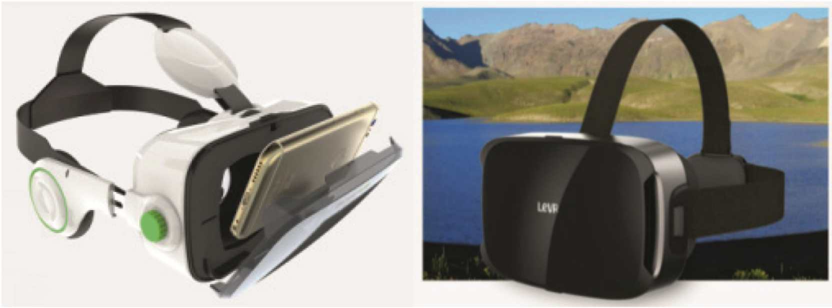

Fig. 2. Some popular VR glasses (domestic).

2.3 Advantages of VR Glasses

In the hardware aspect, as compared to one-piece head devices, VR glasses generally adopt higher resolution display. The display refresh rate is higher with lesser time delay. Moreover, it is myopia barrier-free. In the software aspect, VR glasses offer more in-depth immersive. This narrows the difference between the real and virtual worlds. Better user experience can be obtained. User feels more comfortable, and the display would not make user feel dizzy.

In recent years, the price of VR glasses has been greatly decreased. It is now much more affordable, for example, the cost of a pair of VR glasses with reasonably quality is less than US$1,000.

In terms of convenience in operation, the VR glasses are operating together with the mobile phone via mobile connection such as Bluetooth. More sophisticated applications can be downloaded and executable in the mobile phone. Therefore, the VR glasses can adopt a small-size and light-weight design. These made VR glassses easy to carry and operate.

2.4 VR Glasses for Blended Learning

VR glasses can be effectively used in the blended learning environment. They provide students with a seemingly real learning environment [4]. Students wearing VR glasses can watch to some multimedia such as video and animation.

For example, for learning high school geography, students can be brought to a virtually real environment of a terrain landform to study the topography and climate. With a closer look at the local climate, rivers, topography and other geographical characteristics, VR glasses help deepen the students' understanding of these concepts. For another example, for learning history, students can be brought to the Louvre Museum to understand the French history. With this enriched learning experience, students found the learnt concepts more impressive.

Figure 3 shows the use of VR glasses in the blended learning environment, where the real and virtual worlds are combined for better illustration of concepts and better learning experience.

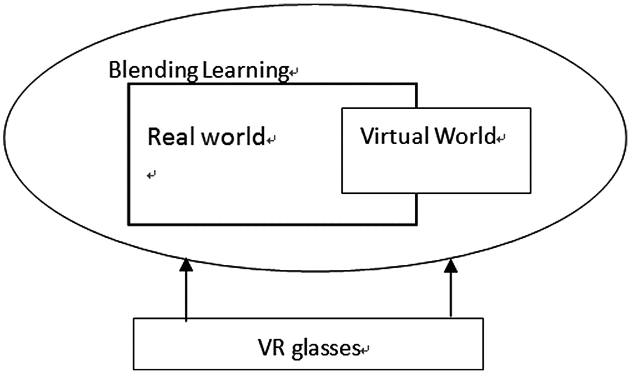

Fig. 3. VR glasses in a blended learning environment.

VR glasses can lead to active classroom atmosphere, arouse the enthusiasm of students. From another angle of view, VR glasses can also be used in watching educational videos and games. It allows the users to experience the 360° panoramic display. For example, students can view the important speeches made by the President of the United States through the VR glasses, or watch a NBA game, where students can enjoy the virtually real environment [5].

3 Examples of Application to Blended Learning

This section describes some examples of applying VR glasses in classroom teaching and blended learning.

3.1 Virtual Environment for Classroom Teaching Content

Nearpod, an education technology company in the United States, launched a VR course to simulate the Google street view with the teaching contents. This course features some special curriculum elements [6]. For example, in a lesson about the history of the Berlin Wall of Germany, students can imagine themselves in a real place in Berlin. They are asked to draw their escape plan, from the 360° view of the Berlin wall. The teacher can use VR technology to create their own teaching contents in accordance with their teaching plan.

Fig. 4. Learning a VR course with Nearpod.

Figure 4 shows a snapshot of the classroom, where children are learning a VR course with Nearpod.

3.2 Traditional Teaching Supplement with Virtual Environment

VR glasses can be used to provide a virtual learning environment to supplement the traditional teaching [7]. Student wearing VR glasses can experience some important scenes with dialogues in a virtual environment. For example, in teaching the history of the Second World War, students are brought to the virtual world to attend the Yalta Conference. This virtual learning environment can effectively supplement the traditional teaching to help reinforce the students' understanding and enrich the students' learning experience. Figure 5 shows a snapshot of the traditional classroom supplemented with VR learning.

Fig. 5. Traditional classroom supplemented with VR learning.

3.3 Integrated Application of Video Camera and VR Glasses

VR glasses together with real-time video camera can create a new virtual space for better learning experience [8]. For example, users can experience a virtual flight feeling with a pair of VR glasses together with a video camera. Users can follow a model flight to appreciate the fun of flying. They can use Google Cardboard and other VR control system to control the flight. Intelligent features are implemented, such as the control by head's movement. Todays, the relevant mobile apps are well available for downloading. Figure 6 shows the integrated application of a pair of VR glasses and a video camera. This integrated application is very useful for training the control of flights, where students can earn virtually real experience without taking risks in a real-life dangerous situation.

Fig. 6. Integrated application of VR glass and video camera for virtual flight experience.

4 Discussion

VR glasses can be widely applied to education, as a virtual learning experience or in combination of the traditional classroom teaching. This creates a new way of teaching and learning that can enhance students' learning interests and enrich students' learning experience.

According to our experience, students are easy to accept using the VR glasses for learning. They welcome this new form of teaching and learning which combines the real and virtual environment, and consider the use VR glasses can help promote the learning effectiveness. They also find that VR glasses are easy to carry and operate. The problem is that the price of VR glasses is still high. Moreover, there is still a lack of applications for teaching and learning.

This paper investigated how VR technology and VR glasses can be effectively applied to teaching and learning. Examples of these applications, especially in a blended teaching and learning environment are shown. It is believed that there are potentials for applying VR glasses in education. With the continuous development of VR technology, we look forwards to more advanced and affordable VR glasses. On the other hand, it is worthwhile to explore new and effective teaching methods with the appropriate application of VR glasses and technology.

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