Simon K. S. Cheung · Jianli Jiao ·
Lap-Kei Lee · Xuebo Zhang ·
Kam Cheong Li · Zehui Zhan (Eds.)

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Technology in Education

Pedagogical Innovations

4th International Conference, ICTE 2019
Guangzhou, China, March 15–17, 2019
Revised Selected Papers

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Preface

This edited volume consists of the extended papers selected from the 4th International Conference on Technology in Education (ICTE 2019), which was held at the South China Normal University, Guangzhou, China, during 15–17 March, 2019.

Technology has become an integral part in virtually all aspects of education, broadly covering curriculum planning, instructional design, content development and delivery, communication among learners, instructors and institution, performance assessment and program evaluation. Enabled by the latest technological advances, new and innovative pedagogies are emerging. Taking "Pedagogical Innovations" as its main theme, ICTE 2019 provided a platform for knowledge exchange and experience sharing among researchers and practitioners in the field of technology in education.

After a careful paper review process, a total of 27 papers were selected for inclusion in this volume. These papers are organized in five groups, namely, blended learning and computer-supported learning; virtual reality, augmented reality and game-based learning; open online courses and open educational resources; teaching and learning analysis and assessment; and pedagogical, psychological and cultural issues.

Our sincere thanks go to the conference's Organizing Committee for their effective administration and unfailing support. Our thanks also go to the international Program Committee. The high quality of the papers could not have been maintained without their professional comments and advices in the paper review process.

May 2019

Simon K. S. Cheung
Jianli Jiao
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Contents

Blended Learning and Computer-Supported Learning

Facilitating Students' Learning Through Problem-Solving in a Computer-Based Expert-Supported Learning Environment

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Abstract. Problem-based learning (PBL) has been widely adopted to help students to develop critical thinking, communication, and problem-solving skills as well as improve the construction of knowledge. However, empirical studies indicate that PBL students hardly develop structured knowledge and efficient reasoning strategies because they are not provided with adaptive guidance and support during problem-solving process. To deal with this challenge, a computer-based expert-supported learning environment is designed and developed to facilitate students' learning in a problem-solving context. Experiment results reveal superior performance on problem-solving and knowledge-construction tasks in students learning under the designed environment. Findings of the study provide important implications to instructional designers and educational practitioners on how to facilitate students' problem-solving learning through the design of a computer-based expert-supported environment.

Keywords: Problem-based learning · Problem solving · Knowledge construction · Expert support · Adaptive guidance

1 Introduction

Problem-based learning (PBL) has been widely adopted to help students to develop critical thinking, communication, and problem-solving skills as well as improve the construction of knowledge. From perspective of constructivism, instructional methods such as problem-based learning and inquiry-based learning allow students to acquire subject-matter knowledge and develop problem-solving skills by searching solutions for concrete problems in situated contexts (Albanese and Mitchell 1993).

Compared to conventional teacher-centered, lecture-based teaching method, self-directed problem-driven learning is advocated in PBL. In PBL curricula, students acquire and elaborate domain knowledge by working on realistic problems by themselves. They are more likely active and cooperative participators than passive recipients

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in learning activities. Correspondingly, instead of imparting knowledge directly, teachers are supposed to work as learning facilitators in PBL contexts (Barrows 1996).

However, previous studies indicate that the scarcity of expert support and adaptive guidance to students is a limitation existed in PBL, which may impede students to construct systemic knowledge and develop effective reasoning skills, and finally influence their problem-solving performance and professional competency (Kirschner et al. 2006). Therefore, instructional techniques and domain expertise are necessary to help students develop structured knowledge and proper strategies in PBL environments (Schmidt and Boshuizen 1993).

To meet the challenge, a computer-based, expert-supported learning environment is designed and developed to facilitate students' learning through problem-solving, in which problem-solving and knowledge-construction processes are captured and externalized. Cognitive strategies are integrated into the learning environment to help students to articulate and reflect on their problem-solving and knowledge-construction processes in an explorative learning environment. Model-centered instruction (MCI) model is adopted to enable students to compare their problem-solving process to that of the expert and identify the key points toward domain expertise. Two research questions of this study are specified as follows:

Q-1: How can a computer-based expert-supported learning environment be designed to facilitate students' learning through problem-solving?

Q-2: What are the effects of the designed learning environment on student problem-solving learning?

2 Relevant Studies

To facilitate students' learning through problem-solving, relevant studies on problem-solving learning are integrated into the design of the proposed learning environment.

From perspective of situated and constructivism learning theory, learning could be facilitated problem-solving contexts, when knowledge is learned in a way that it is used to solve realistic problems in authentic contexts (Brown et al. 1989). Situated learning theory provides students an authentic learning situation that integrates knowledge with contextual practice, which maintain the complexity of real world (Young 1995). Thus, students are more likely to develop in-depth understanding of subject-matter knowledge when it is related to the situation in which it is applied.

Despite offering an authentic learning situation that integrates knowledge with contextual practice, cognitive apprenticeship model provides concrete strategies to scaffold students' learning by externalizing their cognitive and intellectual processes in problem-solving contexts. Therefore, it has been widely used as an instructional model in situated learning contexts, such as problem-based learning environments over the last few decades (Clancey 1992). Cognitive apprenticeship presents certain instructional strategies to provide students with coaching and scaffolding in situated environments for exploration, with support of cognitive modeling for articulation and reflection in problem-solving process, to facilitate expertise development in complex problem-solving contexts (Collins et al. 1989, p. 453). The core idea of cognitive apprenticeship model is scaffolding complex cognitive processes by making tacit knowledge underlying problem-solving activities accessible to students (Collins 1991).

Considering the cognitive process and domain expertise underlying problem-solving activities are usually complex and tacit (Bransford et al. 1989, p. 470), the investigations on cognitive tools and techniques to present and explain the complex cognitive process and expert knowledge underlying problem-solving activities becomes especially important (e.g., Doerr 1996; Gravemeijer 1999). Previous research indicates that experts are more likely to capture key elements to problem solutions by the recognition of solution patterns embedded in their mental models (Alexander 2003; Anderson 1993). Model-centered instruction (MCI) introduces mental models as cognitive tools, consisting of chains of actions and associating related knowledge into problem-solving patterns, to help students to explain their actions and represent their intellectual processes in problem-solving contexts (Greca and Moreira 2000). Particularly, expert mental models are provided as learning guidance in students' accomplishment of complex tasks in expert MCI (Alessi 2000, p. 176). In this way, students are expected to recognize problem-solving patterns and identify the domain knowledge underlying problem-solving processes in an expert manner.

3 Methods

Informed by abovementioned learning theories and instructional models, a computer-based, expert-supported learning environment was designed to facilitate students' learning through problem-solving. Glaucoma diagnosis was chosen as the learning topic for this study because medical diagnosis falls under the category of complex problem solving and it is a common content for medical students. An experiment was conducted in a public medical college in southern mainland China to investigate the effectiveness of the designed learning environment on students' problem-solving learning.

Two diagnosticians with decades of experience in glaucoma diagnosis and treatment from two local hospitals were involved in the experiment. They provided expert knowledge and guidance in preparation of learning materials and assessment of learning outcomes. A teacher from the medical college with years of teaching experience helped to arrange learning activities and tests with students.

4 Design of the Learning Environment

A computer-based expert-supported learning environment was designed and devolved to help students solve diagnostic problems in glaucoma diseases. Main functions of the designed learning environment are presented as follows.

4.1 Diagnostic Problem-Solving Contexts

Students learn to solve 5 diagnostic cases in glaucoma diseases in a way that is similar to clinical encounters in the designed learning environment. All the cases used for learning are selected and adapted from real clinical cases and are double confirmed by the diagnosticians.

Once a case is selected from the case database in the system, relevant information of the simulated patient including background information, medical history and chief complaint is presented to the student. According to the initial information, the student may have a preliminary diagnostic plan consisting a series of clinical examination to collect more information. Results of examinations are displayed in terms of laboratory data and images, based on which the student could make clinical judgements and select the next clinical examination (see Fig. 1). The student is permitted to select any examinations from a list as many as he/she want before reaching a diagnostic conclusion.

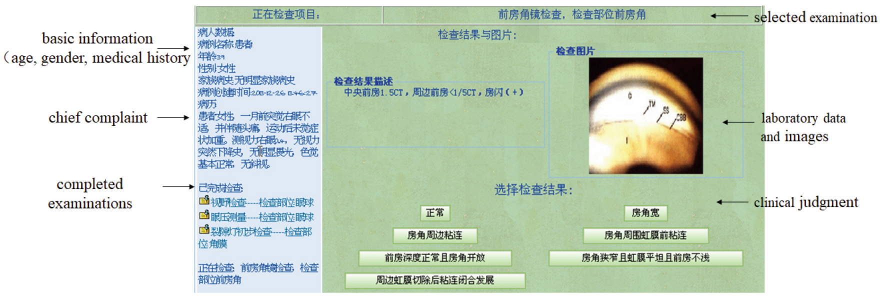

Fig. 1. Diagnostic problem-solving context.

4.2 Modeling of Problem-Solving Process

Students are allowed to diagnose a case as many times as they wanted within the learning program. Each diagnostic process is recorded by the system as diagnostic flowchart in which key points in the process are captured and presented in the designed learning environment. A diagnostic flowchart presents the initial information, clinical examinations, relevant judgments, and a diagnostic conclusion in sequence for each diagnosis (See Fig. 2). The diagnostic flowchart consisting of chains of clinical actions in a sequential order is assumed to reflect reasoning skills and tacit knowledge underlying the problem-solving process (Kinchin et al. 2008).

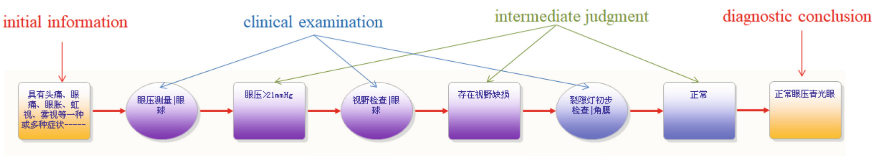

Fig. 2. Modeling of problem-solving process.

In this way, how further information is collected by selecting clinical examinations and making relevant judgment based on incomplete information before reaching a diagnostic conclusion is modeled and demonstrated in a visual format. The model-based problem-solving process reflects the intellectual process students used to understand and approach given problems, and makes it become accessible for students to observe, enact, and practice. Furthermore, changes in students' model-based problem-solving process provide visible evidence on their learning development.

4.3 Expert-Supported Reflection on Problem Solving

For each diagnosis, the diagnostic flow of the expert will be presented in the designed learning environment when the degree of similarity between the student and expert in diagnosing a learning case reached 60% or more (See Fig. 3). Not only the key elements such as clinical examinations and relevant judgements, but also the logic relations are taken into consideration in the calculation of similarity. Moreover, feedback from the system and comments from experts on each problem-solving process can be viewed by the student, indicating the key points and possible errors in diagnosing the case.

Based on the feedback, the student would be able to find how his/her diagnostic process is different from that of the expert. Expert-supported reflection on problem solving helps students to identify the implicit knowledge embedded in problem-solving process and adjust their reasoning strategies in dealing with the next diagnosis.

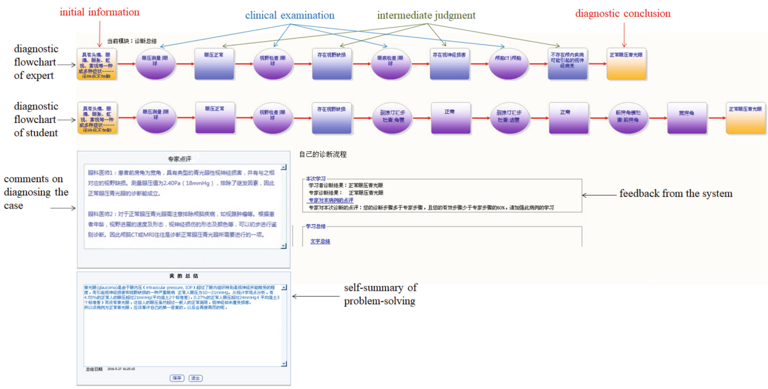

Fig. 3. Expert-supported reflection on problem solving.

4.4 Facilitation of Knowledge Construction

Knowledge structure could be deemed as the internal structure in which relevant ideas or concepts are interrelated that people used to process external information and approach given problems (Patel et al. 1994, p. 188). A well-organized knowledge structure looks like an elaborate, highly-integrated framework in which relevant concepts are highly and meaningfully interconnected to represent in-depth understanding of domain expertise (Feltovich et al. 1993, p. 126). Therefore, students' abilities to construct knowledge are closely related to their performance in problem-solving tasks (Shin et al. 2003).

To help students to frame related concepts and ideas in problem-solving contexts, and make it becomes more retrievable when dealing with similar problems, a graphic tool is provided to students in the designed learning environment. Students would be able to draw a comprehensive mental map to reflect their problem-solving expertise acquired from worked cases (See Fig. 4). The process of drawing a metal map is similar to the construction of relevant domain knowledge, which requires the student to identify the core steps in dealing with the problems and integrate them into a network. In this sense, a mental map that is regarded as the learning product of student in the designed learning environment may reflect the structure of domain knowledge in his/her mental model and predict his/her performance in problem-solving tasks to some extent in future.

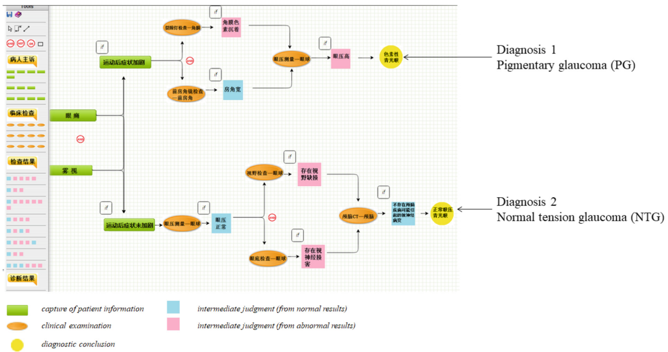

Fig. 4. Facilitation of knowledge construction.

5 Evaluation of the Learning Environment

An experiment was conducted in a public medical college in southern mainland China to investigate the effectiveness of the designed learning environment on students' problem-solving and knowledge-construction performance. 50 senior undergraduate students (fourth-year undergraduate) from two classes participated in the experiment on a voluntary basis. To avoid interaction between participants from the same class during the experiment, they were divided into two groups. 25 students from one class were assigned the experimental group; while 25 students from the other class were assigned to the control group.

At the beginning of the learning program, students were asked to complete a pre-test consisting of (1) a diagnostic problem-solving task as the measure of students' initial problem-solving abilities, and (2) a standardized knowledge test as the measure of students' preliminary level of domain knowledge. Tversky's contrast model (Tversky 1977) was used to evaluate students' performance in diagnostic problem-solving tasks. Based on Tversky's contrast model, key elements (i.e., clinical examinations used to collect further information, intermediate judgments based on examination results, and diagnostic conclusion) as well as scales for each element (i.e., number of valid, redundant and missing items by making comparison to the expert) in diagnostic problem-solving process were identified. Thus, the degree of similarity between the student and the expert in completing a diagnostic task was automatically calculated by the system as the measure of students' performance in the diagnostic problem-solving task.

The learning program lasted for six weeks and no teacher involved except a teacher assistant showing students how to use the learning system and helping them with technical problems during the experiment. Students were suggested to pace themselves and spend three to four hours on learning each case. Students in the experimental group used the designed learning environment to learn to diagnose five cases on glaucoma disease; while students in the control group used another similar system but without expert support and modeling tools to learn to diagnose the same five cases.

At the end of the learning program, students were asked to complete a post-test consisting of (1) a survey questionnaire to collect students' perceptions of cognitive strategies supported by the learning environment, (2) a diagnostic problem-solving task with the same level of difficulty as that in the pre-test as the measure of students' problem-solving abilities after the learning program, (3) drawing of a mental map to represent and connect reasoning process and subject-matter knowledge underlying all five learning cases using a graphic tool provided by the system. The assessment of mental map was essentially the same as that of the performance in diagnostic problem-solving tasks.

6 Results

45 students (25 of experimental group, 20 of control group) completed the entire learning program in the experiment. The level of students' computer skills was reported between good (58%) or intermediate (42%); and most had a strong intention to use computer-assisted learning (82%).

6.1 Problem-Solving Performance

Results of descriptive statistics and independent sample t-test on students' performance on diagnostic problem-solving tasks in pre- and post- tests are given in Tables 1 and 2 respectively. As shown in Table 1, there were no significant differences in scores of diagnostic problem-solving performances between two groups in the pre-test in each scale ($P\_CA = .410$, $P\_IG = .593$, $P\_DC = .697$, $P\_Overall = .433$). The results indicate that students of two groups had equivalent problem-solving abilities before the learning program.

Table 2 shows that students of the experimental group had significantly higher scores of performances in diagnostic problem-solving tasks than did those of the control group in most scales in the post-test ($P\_CA = .002$, Cohen's $d = 1.05$; $P\_IG = .000$, Cohen's $d = 1.25$; $P\_Overall = .009$, Cohen's $d = 0.83$), except the scale of diagnostic conclusion ($DC\_P = .738$). The results indicate that students of the experimental group generally had superior problem-solving abilities than did those of the control group after the learning program. The differences in mean values between the experimental group and the control group was greatest in intermediate judgement based on examination results (0.54 vs. 0.29) among all the scales.

Table 1. Descriptive statistics and independent sample t-test on students' problem-solving performance in diagnostic tasks in pre-test.

Scales		Descriptive statistics				Independent sample t-test	
		EG (n = 25)		CG (n = 20)			
		M	*SD*	*M*	*SD*	*df*	*P*
CA	Number of valid items	1.76	.72	1.45	.76	43	.169
	Number of redundant items	4.32	1.35	3.80	1.96	43	.298
	Number of missing items	1.24	.72	1.65	.88	43	.092
	Similarity to expert	.38	.15	.34	.16	43	.410
IG	Number of valid items	.80	.76	.60	.68	43	.365
	Number of redundant items	5.28	1.54	4.55	2.01	43	.175
	Number of missing items	1.24	.72	1.65	.88	43	.092
	Similarity to expert	.18	.17	.15	.18	43	.593
DC	Number of valid items	.08	.28	.05	.22	43	.697
	Number of redundant items	.92	.28	.95	.22	43	.697
	Number of missing items	N/A	N/A	N/A	N/A	N/A	N/A
	Similarity to expert	.08	.28	.05	.22	43	.697
Overall	.21	.14	.18	.13	43	.433	

EG: Experimental Group CG: Control Group
CA: Clinical examination to collect further information
IG: Intermediate judgment based on examination results
DC: Diagnostic conclusion
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

Table 2. Descriptive statistics and independent sample t-test on students' problem-solving performance in diagnostic tasks in post-test.

	Scales	Descriptive statistics				Independent sample t-test	
		EG (n = 25)		CG (n = 20)			
		M	*SD*	*M*	*SD*	*df*	*P*
CA	Number of valid items	3.36	.86	2.10	1.12	43	.000**
	Number of redundant items	2.80	1.66	3.10	1.12	43	.493
	Number of missing items	.64	.86	1.90	1.12	43	.000**
	Similarity to expert	.67	.19	.45	.24	43	.002**
IG	Number of valid items	2.60	1.00	1.25	.91	43	.000**
	Number of redundant items	3.72	1.82	4.00	1.08	43	.524
	Number of missing items	.64	.86	1.90	1.12	43	.000**
	Similarity to expert	.54	.20	.29	.21	43	.000**
DC	Number of valid items	.40	.50	.35	.49	43	.738
	Number of redundant items	.60	.50	.65	.49	43	.738
	Number of missing items	N/A	N/A	N/A	N/A	N/A	N/A
	Similarity to expert	.40	.50	.35	.49	43	.738
Overall		.54	.18	.37	.24	43	.009**

EG: Experimental Group CG: Control Group
CA: Clinical examination to collect further information
IG: Intermediate judgment based on examination results
DC: Diagnostic conclusion
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

6.2 Knowledge-Construction Performance

The results indicate that students of two groups had equivalent problem-solving abilities before the learning program. Results of descriptive statistics and independent sample t-tests on knowledge test in the pre-test are presented in Table 3. As shown, there was no significant difference in the test scores between the experimental group (Mean = .48, SD = .08) and control group (Mean = .47, SD = .08; P = .816) in the pre-test. The results indicate that students of two groups had equivalent level of subject-matter knowledge before the learning program.

Table 3. Descriptive statistics and independent sample t-tests on knowledge test in the pre-test (scores normalized between 0 and 1).

Descriptive statistics				Independent sample t-test	
EG (n = 25)		CG (n = 20)			
M	*SD*	*M*	*SD*	*df*	*P*
.48	.08	.47	.08	41.562	.816

EG: Experimental Group CG: Control Group
**p < .05; **p < .01; ***p < .001.*

Descriptive statistics and independent sample t-tests results on students' knowledge-construction performance, based on the tasks of drawing a mental map in the post-test are presented in Table 4. As shown, students of experimental group had significantly higher scores on the drawing tasks than did those of control group in the post-test on most scales (P_CA = .000, Cohen's d = 1.39; P_IG = .000, Cohen's d = 1.82; P_Overall = .000, Cohen's d = 1.33), except the scale of diagnostic conclusion (DC_P = .279). The results indicate that students of experimental group had better knowledge-construction performance than did those of control group on the whole after the learning program. The differences in mean values between the experimental group and the control group was greatest in intermediate judgement based on examination results (0.57 vs. 0.35) among all the scales.

Table 4. Descriptive statistics and independent sample t-tests on the drawing task of mental map.

	Scales	Descriptive statistics				Independent sample t-test	
		EG (n = 25)		CG (n = 20)			
		M	*SD*	*M*	*SD*	*df*	*P*
CA	Number of valid items	9.48	2.40	7.35	1.79	43	.002**
	Number of redundant items	4.44	2.42	7.00	2.00	43	.000**
	Number of missing items	6.68	2.43	8.65	1.79	43	.004**
	Similarity to expert	.63	.13	.48	.08	43	.000**

(*continued*)

Table 4. (*continued*)

	Scales	Descriptive statistics				Independent sample t-test	
		EG (n = 25)		CG (n = 20)			
		M	*SD*	*M*	*SD*	*df*	*P*
IG	Number of valid items	8.60	2.45	5.25	1.89	43	.000**
	Number of redundant items	5.44	2.96	9.60	2.37	43	.000**
	Number of missing items	7.52	2.55	9.75	1.80	43	.002**
	Similarity to expert	.57	.14	.35	.10	43	.000**
DC	Number of valid items	3.48	.86	3.20	.62	43	.213
	Number of redundant items	1.52	.82	1.80	.62	43	.213
	Number of missing items	N/A	N/A	N/A	N/A	N/A	N/A
	Similarity to expert	.81	.12	.77	.10	43	.279
Overall		.64	.13	.50	.07	43	.000**

EG: Experimental Group CG: Control Group
CA: Clinical examination to collect further information
IG: Intermediate judgment based on examination results
DC: Diagnostic conclusion
**p < .05; **p < .01; ***p < .001.*

7 Implications and Conclusion

This study is an empirical attempt to design a real-life problem-solving learning environment into which cognitive strategies and expert support were integrated. The study has some practical implications for instructional designers and education practitioners in such complex problem-solving domain as medical education.

First, the results of this study revealed that cognitive apprenticeship and model-centered instruction (MCI) could be effective pedagogies to improve students' problem-solving and knowledge-construction performances in problem-based learning (PBL) environments when successfully implemented by virtue of information technology. Modeling of and reflection on of problem-solving process are the key factors in making cognitive process visible. Thus, students could be able to understand how domain knowledge and reasoning strategies are related to reach the solution of a given problem. This aligns with the results of related studies, that computerized models have potentials in scaffolding students' scientific understanding (De Jong et al. 1999; Monaghan and Clement 1999).

Second, cognitive tools such as mental maps could be used to help students to construct functional mental models, in which subject-matter knowledge and reasoning strategies underlying problem-solving processes are excavated and interconnect. In view of this, the design of appropriate tools to externalize mental models is essential to achieve model-centered leaning (MCL) in complex problem-solving domain. This is consistent with previous empirical studies that found that, students are more likely to exhibit superior performance in completing complex tasks when they are able to externalize problem-solving processes and implicit knowledge underlying the tasks by using computer-based cognitive tools (Wang et al. 2013; Wu et al. 2016).

Last, but by no least, expert support plays an important role in students' learning reflection in complex problem-solving context. When provided with expert's diagnostic flowchart in this study, students are more able to identify the difference between themselves and the expert in completion of complex tasks, and may develop expert-like reasoning strategies and knowledge structures. By comparing the features of their mental models with those of experts, students are able to extract problem-solving expertise embedded in complex tasks and ultimately assimilate it into their own knowledge base (Brown et al. 1989; Collins 1991). This confirms the conclusions of previous studies that indicate that novices are more likely to make sense of their learning and construct highly structured domain knowledge when experts' mental models became accessible to them (Grosslight et al. 1991).

In conclusion, this study explores the design and effectiveness of a computer-based expert-supported learning environment to improve students' problem-based learning by scaffolding their reflection on problem-solving and knowledge-construction processes. For this purpose, expert knowledge and problem-solving process are externalized in visual forms and integrated into the designed learning environment, to help students to reflect on and identify the reasoning strategies and subject-matter knowledge underlying problem-solving processes. The results show that the designed learning environment has positive effects on students' problem-solving skills and knowledge-construction performances in terms of clinical examination to collect further information and intermediate judgment based on examination results, with the exception of diagnostic conclusion. One possible explanation for this is that some students made a correct diagnostic conclusion not based on correct reasoning. This might indicate that the designed learning environment is conducive to developing students' reasoning skills rather than problem-solving results. Further studies involve the investigation on long-term effects of the designed learning environment on students' problem-solving learning through a follow-up evaluation study, and the investigation of the designed learning environment in other related domains.

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Using Corpus-Aided Data-Driven Learning to Improve Chinese EFL Learners' Analytical Reading Ability

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Abstract. Data-driven learning (DDL) has been proved successful in improving learners' English language skills (Chen and Flowerdew 2018; Larsen-Walker 2017; Gui et al. 2010; He 2010). This study investigates a relatively under researched aspect, i.e., whether corpus-aided DDL can help learners improve their analytical reading ability. In a 6-week teaching experiment with a class of 31 advanced Chinese EFL learners, different corpus processed materials such as *keywordlists* and *concordances* were used to assist the subjects towards a deeper and quicker understanding of the texts. A post-study questionnaire survey and interviews obtained positive comments by the subjects. Based on the students' feedback, a reading-writing experiment was further conducted to three more classes (135 students in total) using three different instructional modes, i.e., sheer teacher instruction, sheer corpus processed input, and teacher instruction plus corpus processed input. The study found corpus-aided DDL targeted at learner needs effective in improving the subjects' reading capacity.

Keywords: Corpus-aided input · DDL · Analytical reading

1 Introduction

Integration of technology with education has become an ideology of teaching and learning highly sought after for the last two decades as it brought about new opportunities, resources, useful tools and methods to teachers and learners. With regard to language teaching and learning, data-driven learning (DDL) advocates learner engagement through technology means which has been found effective in enriching EFL learners' learning experience and providing opportunities for them to explore language knowledge and language use. Researchers reported on how corpus-based or corpus-aided DDL has been used in assisting learners with their English language development (Chen and Flowerdew 2018; Larsen-Walker 2017; Gui et al. 2010; He 2010).

While the DDL approach has been applied to learners' English writing, grammar or vocabulary enhancement, a relatively less researched on aspect concerns the influence of DDL on the development of advanced EFL learners' analytical reading ability.

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The current study designed a 6-week teaching using different corpus processed materials such as *wordlists*, *keywordlists*, and *concordances* to a class of 31 advanced Chinese EFL learners with a purpose of helping them to gain a deeper and quicker understanding of the texts. A post-study survey was conducted which found that the subjects responded to the approach positively. In order to verify some feedback by the subjects with regard to the corpus-aided approach, a reading-writing experiment was further conducted to three more parallel classes (135 students in total) using three different instructional modes. Class A were required to write a summary after reading a text with teacher instruction, while Class B finished the writing after reading the same text but with additional corpus-aided input. Class C finished the same task with both teacher instruction and corpus-aided input. The data obtained provide further evidence that DDL is effective in helping the subjects establish a deeper understanding of the text, and that the students performed the best under the mode of corpus-aided input with teacher instruction.

2 Corpus-Aided Reading Teaching for EFL Learners

Data-driven learning is a special language teaching and learning approach which enables students to make use of corpus to explore specific linguistic issues through authentic language materials. The theory underpinning it is corpus linguistics, which could be applied far beyond the discipline itself (McEnery et al. 2006: 8). Cobb and Boulton (2015) suggest that its methodologies make great influence on improving description of language varieties and features, which are important factors in language teaching. The activities design of DDL, namely, corpus-based learning, covers a wide range from "hard" to "soft" (Bernardini 2004; Gabrielatos 2005), depending on the degree learners themselves can take over the learning stages (Cobb and Boulton 2015).

For its diverse advantages, DDL is a frequently discussed issue in language teaching. Cobb and Boulton (2017) review 64 studies and find that most of the relevant studies focus on corpus-based learning of vocabulary from the lexicogrammar or grammar perspective. They argue DDL plays an excellent role in helping learners deal with the great difficulties they encountered in producing natural and effective language. Johns (1991) analyses two samples of DDL materials and states that this approach provides a new style of "grammatical consciousness-raising" (Rutherford 2014), which is different from the traditional teaching approach that presents students with a set of "rules" directly.

Apart from the studies which focus on grammar and vocabulary, few scholars pay attention to the application of corpus to reading teaching. The feasibility and advantages were not fully researched on. Cobb and Boulton (2015) point out that corpus tools can be flexibly adjusted and applied to individual texts. It is helpful in deciding what elements of a text can be paid great attention to. Such concentration can help teachers decide on reading activities to be conducted. Except for its feasibility, research shows the strengths of incorporating technology with reading instruction. After reviewing 42 studies, scholars (Jamshidifarsania et al. 2019) agree that the combination of technology and reading instruction is able to increase motivation, reduce cognitive load and allow students learn at their own pace. A higher motivation coupled with less reading anxiety is useful in improving reading effects. Others (Kamil and Chou 2009; Boekaerts and Corno 2005; Zimmerman and Tsikalas 2005) point out the potential for teaching reading through computer-based approach and the benefits it holds. As one of the pioneers, Hadley and Charles' (2017) study reveals the effects of DDL in reading instruction and confirms that this method has positive effect on the extensive reading program the study designed.

Studies cited above laid some foundation for the corpus-aided approach in reading teaching the present study attempts to explore. What sets it apart from previous studies is its concentration on enhancing students' analytical reading which is a kind of in-depth reading. According to Chall (1983) who divides reading ability development into five stages based on Piaget's cognitive development theory, college students are at the stage of having their analytical reading ability quickly developed. Learners at such a stage attempt to establish their view of the world via reading and analyzing different types of texts. They make inferences, judgments, and draw their own conclusions by interacting with the texts. Besides, they develop their logical thinking abilities by analyzing the themes contained in the texts, textual development features, language and rhetoric features, etc. For English major students at college level, they are required to develop excellent English skills and are expected to enhance their critical thinking ability which can be demonstrated through analytical reading performance. Such an expectation is clearly indicated in the nationally used *Syllabus of English Teaching for English Majors of Higher Education* published by China's Ministry of Education (2000).

As improving Chinese advanced EFL learners' analytical reading ability becomes a goal in English education currently, a question concerning how it can be empirically done arise. Besides, how the teaching can be assisted through technology to improve its effects is also to be considered. The corpus-aided approach of the study makes use of a user-friendly corpus tool, AntConc 3.2.0. (Anthony 2014) which can quickly present very useful information of a text or texts such as *keywordlist*, *concordances* and *n-grams* (clusters of different number of words centering around certain words). With this core information, teachers can guide students towards understanding of the theme of a text, considering how it develops into sub-themes, and what and how language forms are used for the making of aboutness of a text. Besides such guided analysis which students can do, their reading effects can be enhanced because DDL approach provides them with autonomous chances of exploration, i.e., they are engaged in making attemptive analysis of different kinds of materials the corpus tools instantaneously offer.

3 Research Design

3.1 Research Questions

In order to examine the effectiveness of corpus-aided teaching of reading, the study aims at answering the following questions: (1) How can the teaching of analytical reading make use of the corpus method and tools? (2) Can corpus-aided DDL help Chinese advanced EFL learners improve analytical reading performance?

To answer the first question, a 6-week teaching experiment of corpus-aided instruction was conducted. To answer the second question, a post-study questionnaire survey, interviews, and a reading-writing experiment were carried out.

3.2 Participants

The teaching experiment with the questionnaire survey and interviews took place in April to May of 2016. A class of 31 students participated. They were third-year English majors who had all passed *Test for English Major Band 4* with an English proficiency level comparable to IELTS 6.0–6.5. They had taken the course of Corpus Linguistics in the previous term and were familiar with the corpus tools used in this study. In the second stage of the study, three classes of 135 second-year English majors participated in a 40-min reading-writing experiment. They had also taken the course of Corpus linguistics and were familiar with corpus tools used in this study.

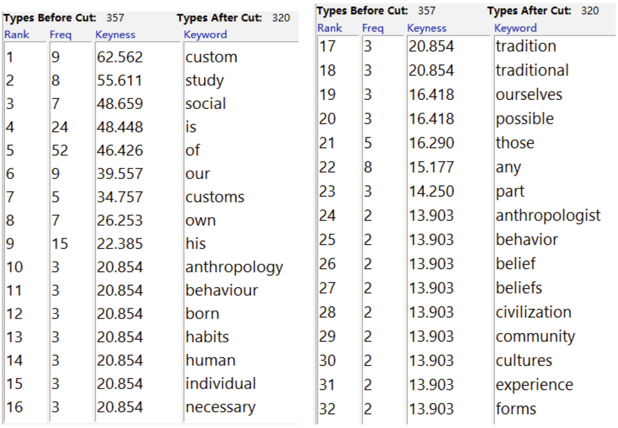
3.3 The Corpus and Tools

A mini corpus of five reading passages taken from an intensive reading course for English major students was constructed for the teaching experiment. Table 1 shows the titles and lengths of the texts.

Table 1. The five texts used in the study

Title	The science of custom	Beauty	Appetite	Euphemism	Teaching as mountaineering
Word count	876	1007	733	1332	1578

The corpus software used in the study is AntConc (Anthony 2014). The main tools used are *keywordlist* and *concordance*. *Keywords* in Corpus linguistics refers to a list of words of a text (or texts/corpus) which are unusually frequent (with statistic significance) when compared with a wordlist of a referent text (or texts/corpus). The reference is of data from different topics and of a larger word size (at least five times more). Figure 1 shows a part of the keywordlist extracted from the text The Science of Custom. The higher the keyness value, the greater the difference in word frequency between the target text and the reference corpus. Keyness is regarded as a mostly textual quality (Scott and Tribble 2006). Keywords often indicate the aboutness and stylistic features of a text.



Rank	Freq	Keyness	Keyword
1	9	62.562	custom
2	8	55.611	study
3	7	48.659	social
4	24	48.448	is
5	52	46.426	of
6	9	39.557	our
7	5	34.757	customs
8	7	26.253	own
9	15	22.385	his
10	3	20.854	anthropology
11	3	20.854	behaviour
12	3	20.854	born
13	3	20.854	habits
14	3	20.854	human
15	3	20.854	individual
16	3	20.854	necessary
17	3	20.854	tradition
18	3	20.854	traditional
19	3	16.418	ourselves
20	3	16.418	possible
21	5	16.290	those
22	8	15.177	any
23	3	14.250	part
24	2	13.903	anthropologist
25	2	13.903	behavior
26	2	13.903	belief
27	2	13.903	beliefs
28	2	13.903	civilization
29	2	13.903	community
30	2	13.903	cultures
31	2	13.903	experience
32	2	13.903	forms

Fig. 1. Extract of keywordlist

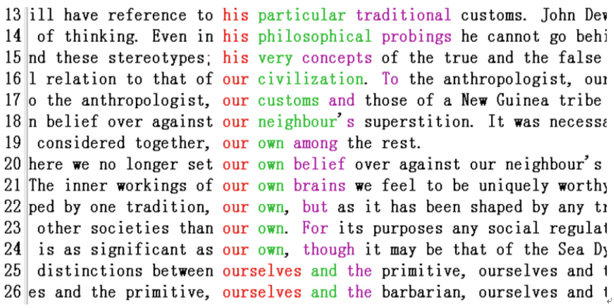


Fig. 2. Part of the concordance lines of *his, our, ourselves*

Concordance refers a tool which searches a text or a corpus for a selected word or phrase (a node) and presents every instance of the node in the center, with words that come before and after the node presented to the left and right. Concordance lines are the instances the tool presents in accordance with the nodes keyed in. Some corpus tools such as AntConc provides a function which allows users to sort and highlight words of different distance to the left or right of the node. Figure 2 shows what concordance lines look like.

3.4 The Teaching Experiment

In the teaching experiment, there were four lessons each week, each lasting for 40 min. The first week was used to demonstrate how corpus-aided analytical reading was carried out. In the following four weeks, the students studied four passages using the corpus-aided DDL method. In the last week, the questionnaire survey and interviews were carried out. The corpus-aided teaching method consisted of the following steps:

1. Prepare a corpus of the reading passages ready to be searched by AntConc.
2. Prepare the students with the tools used, reviewing the functions of AntConc, i.e. *wordlist, keywordlist, concordances*, and *collocates*.
3. Demonstrate to the students how to make keyword lists (the content words with significant keyness indicated in Fig. 1) and guide them to analyze and categorize the words, as shown in Table 2.

Table 2. Keywords identified and categorized from The Science of Custom

Noun						Adjective		Verb	
Type	Token	Type	Token	Type	Token	Type	Token	Type	Token
custom(s)	13	part	3	institutions	2	social	7	born	3
study	8	human	3	impossibilities	2	own	7	weighting	2
behavior	5	cultures	2	forms	2	individual	3	group	2
Anthropology (gist)	5	role	2	experience	2	necessary	3		
belief(s)	4	varieties	2	community	2	possible	3		
matter	4	sciences	2	civilization	2	traditional	2		
habits	3	propositions	2			interested	2		
tradition	3	laws	2						
Word types 22; Tokens 75						Word types 7; Tokens 27		Word types 3; Tokens 7	
Total word types 32; Total tokens 109									

4. Guide students to make prediction, and discuss possible connections, logic relationships of the items on the keywords list.
5. Have students' attention focus on the most important keywords and use them as nodes to work out the concordance lines for analytical reading. Figure 3 shows part of the concordance lines of *custom.**[1] Figure 4 shows how guided reading on the words and phrases associating with the nodes is done.

2	eat gamut of custom that is found in various cultures, and hi
3	in which the customs of any peoples function in the lives of
5	igation, but custom, we have a way of thinking, is behavior a
6	Traditional custom, taken the world over, is a mass of detai
7	nt role that custom plays in experience and in belief, and th
8	inite set of customs and institutions and ways of thinking. E
10	rt played by custom in shaping the behavior of the individual
11	traditional custom, is as the proportion of the total vocabu
12	is birth the customs into which he is born shape his experien

Fig. 3. Part of the concordance lines of custom*

[1] In AntConc, * is a wildcard for zero or more characters. *Custom** therefore includes *custom* and *customs*.

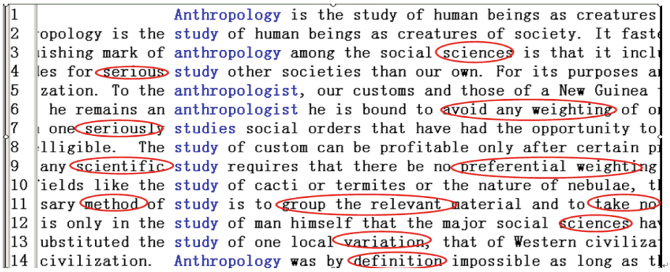


Fig. 4. Part of the concordance lines of *study* and *anthropolog**

6. Encourage students to use corpus tools to read for key information, identify how the information is organized, and find out the deep meanings underneath the text, etc. by helping them understand the theme and its supporting sub-themes, meanings contained in keywords, and their possible logical connections.
7. Have students read the text and bear the analysis they have done with the corpus data in mind to confirm and deepen their understanding.
8. After Week one's demonstration, students were required to do the corpus-aided DDL reading for four weeks with necessary teacher guidance.

After the teaching experiment, a questionnaire survey was carried out to gather responses from the students. Part One of the survey attempted to find out to the students' opinion about the effect of the teaching method, and Part Two focused on their suggestion for the use of the method by having them answer a multiple-choice question (see Table 4). On the basis of the survey, follow-up interviews were conducted with some of the students.

3.5 The Reading-Writing Experiment

The survey and interviews after the teaching experiment suggests that the students expected to have the corpus processed input prior to reading, and that they would like to have teacher guidance for using the corpus materials. To further investigate the significance of teacher instruction in DDL, a reading-writing experiment was conducted. Three classes of English-major students from the same cohort (classes A, B, and C) were required to read a passage with different methods of instruction and to write a summary of it at the end of the experiment.

The reading passage used in the experiment was a 1674-word essay *Some Thoughts on Writing*[2]. The additional corpus materials included a keyword list and concordance lines of selected keywords of the passage. AntConc was used to compare the reading passage with the rest of the same textbook (79,960 words). The theme of the passage on writing can be inferred from some of most salient keywords such as *writing, write, work, how, published*, *rejected*, etc. The frequent mention of first-person and second-

[2] The article was written by Elizabeth Gilbert and was adapted in *A New English Course* Book 4 unit 3 intended for second-year English majors.

person pronouns such as *I, my, you, your,* etc. is a feature of the dialogic style of the writing. In addition, concordance lines were extracted for three selected keywords, *write, you*, and *I as well as* their inflectional forms.

The methods of instruction involved two variables: form of input and teacher instruction. Class A read the passage with teacher instruction. Class B were given both the passage and corpus-aided materials, but no teacher instruction. Class C were provided with the passage as well as the corpus input with teacher instruction. The instruction provided to Class A was regular directions in a reading lesson and brief guidance about the topic and organization of the text, while in Class C it focused on the reading of the concordance lines, especially on guiding the students' attention to words and expressions indicating the topic and subtopics of the reading passage.

The experiment was carried out in language labs. It lasted for 40 min, within which the reading process and the writing task were completed. The summaries were written directly on computer and were collected at the end of the experiment. Among the 135 pieces of summary collected, 16 of them being too short or not in the proper form of summary were excluded. The remaining 119 valid copies of summary were used as the final data of the study. Table 3 provides description of the summaries collected.

Table 3. Description of the summaries collected

Group	Instruction		No. of text	Token	Type
	corpus-aided input	Teacher instruction			
Class A	–	+	42	4374	667
Class B	+	–	34	5368	885
Class C	+	+	43	5947	786

After the summaries were gathered they were carefully graded with the following criteria: (1) *Main idea coverage* which focuses on the number of main ideas included in the written summary; (2) *Integration* which examines the extent to which the information in the text is presented succinctly; and (3) *Language use* which focuses on correctness of grammar and vocabulary use. Four independent raters were invited to do the rating and an average score of each summary was obtained.

4 Results and Discussion

The results of the questionnaire survey are shown in Table 4. The results from Part One show that the students had a positive attitude towards the teaching method. 93.4% of them agreed that the corpus-aided method improved their understanding of the theme and main ideas. 75.8% reported that the method was more likely to attract their attention to the language forms. 83.3% stated that the method deepened their understanding of the meaning of the keywords and their contribution to the logic development of the texts.

Table 4. Results of the survey

Part One						
Item	A Strongly agree No./%	B Agree No./%	C Not sure No./ %	D Disagree No./%	E Strongly disagree No./%	Total number and %
1. The corpus aided teaching can help me improve my understanding of the theme and main ideas better	8/26.7	20/66.7	1/3.3	1/3.3	0/0	30/100%
2. The corpus aided teaching is more likely to attract my attention to the language forms	5/17.2	17/58.6	5/17.2	2/6.9	0/0	29/100
3. It helps me deepen my understanding of what the keywords mean and how they contribute to the logic development of the texts	4/13.3	21/70	5/16.7	0/0	0/0	30/100
Part Two						
What would you like to see more for better use of the method? (multiple choices)	A More introduction of the corpus tools and techniques					16/77 20.8%
	B Use it before analyzing the text in detail					18/77 23.4%
	C Use it after analyzing the text in detail					7/77 9.1%
	D Print the materials out for reading					11/77 14.3%
	E Teacher guided reading					25/77 32.5%

The data of Part Two indicate that the students had a higher expectation for teacher guided reading with corpus-aided input. It is the top choice they selected, taking up a third of all the choices they made. Compared with other aspects such as further explanation of the use of the tools, whether printed input is necessary and the time to use the corpus-aided materials, the students regarded teacher guidance to be more important.

The reason students positively commented on the corpus-aided DDL in reading is due to the fact that they were more engaged in reading. While they explored the theme of the text and its development, they were given bottom-up data centering on the keyness of a text. The corpus tools which instantaneously highlight the keywords, and the different neighbouring words of the nodes in concordance lines can help focus students' attention on forms and observe how meanings are constructed. In the follow-up interviews, students reported that they were able to "quickly grasp the main theme and relationships of topic and sub-topics" while in traditional reading class they "tend to read word by word or line by line from the beginning to the end and still miss the core meaning". They stated that "exploration of the texts is more effective because specific tasks are given", and that "the rich data displayed and the requirements to work out the themes and the underneath meanings help to improve my critical reading ability".

With regard to the reading-writing experiment, the treatment of both corpus-aided input and teacher instruction proved to be most effective in helping the students with summary writing. Table 5 shows the results of the experiment.

Table 5. Statistics of results of the reading-writing experiment

Descriptives

Score

	N	Mean	Std. Deviation	Std. Error	95% confidence interval for mean	
					Lower bound	Upper Bound
Class A	42	76.5476	6.65693	1.02719	74.4732	78.6221
Class B	34	79.5294	7.68996	1.31882	76.8463	82.2126
Class C	43	81.1047	7.51155	1.14550	78.7929	83.4164
Total	119	79.0462	7.47340	.68509	77.6896	80.4029

ANOVA

Score

	Sum of squares	df	Mean square	F	Sig.
Between groups	452.341	2	226.171	4.274	.016
Within groups	6138.154	116	52.915		
Total	6590.496	118			

The mean scores of summary writing of classes A, B, and C are 76.55, 79.53 and 81.1 respectively. Classes B and C with corpus-aided input performed better than Class A who received no corpus-aided input. Class C with both corpus-aided input and teacher guidance performed the best. Its mean score is significantly higher than that of Class A, suggesting that teacher-guided use of corpus-aided materials is effective in enhancing analytical reading.

Summary writing is an important output skill which is closely related to one's reading quality. A good summary includes the main idea of the text, the most essential supporting details and the use of paraphrasing skills with correct grammar and vocabulary. The skill to handle these elements in summary writing has much to do the students' critical reading ability which lays a foundation for the writing. The experiment provides evidence of the positive influence of the mode of corpus-aided input with teacher guidance on analytical reading. It also indicates the importance of considering learner needs in teaching, namely, in-depth interaction with bottom-up data will be more effective when coupled with proper guidance and challenge from teacher-student interactions.

5 Concluding Remarks

The present study constructed a 6-week reading teaching experiment with Chinese advanced EFL learners using the corpus-aided DDL method. The effect of the method was investigated through a questionnaire survey, interviews and a follow-up reading-writing experiment. Different from previous studies which used much larger corpus when applying the DDL approach, the study concerns single texts. It shows how corpus tools can be used to assist analytical reading and language learning. The corpus-aided bottom-up method helps students to focus on the most relevant information of a text. When students observe keywords, concordances, clusters centering on the nodes, etc., they are exploring how the theme and its sub-topics or supporting details developed. When reading keywordlists, for example, they make comparison and categorization of the contents. When observing concordance lines of selected nodes, they make inference and evaluation of the ideas expressed.

The integration of technology with teaching brings about chances for classroom teaching innovation. The present study suggests that the effect of such innovations can be mediated by the teacher instruction provided. In addition, it provides implications for further research applying the corpus-aided DDL method to reading teaching of more texts in one particular discipline or subject area.

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Secondary Students' Views on Using Flipped Classroom to Learn Computer Programming: Lessons Learned in a Mixed Methods Study

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Abstract. This study was designed to explore how secondary students perceive the use of flipped classroom for learning computer programming. Specifically, it aimed to investigate the effects of flipped classroom on students' learning and acquisition of programming knowledge and skills. Flipped classroom is known as a blended learning approach in which learning materials are delivered online, out of class for self-study in advance of classes, while homework assignments are transformed into class activities. This approach leverages technology and digital resources to support students in independent and online learning. It also enables teachers to minimize direct instruction and maximize student involvement in both teacher-student and student-student interactions. In this study, forty students from two Information and Communications Technology (ICT) classes (18 students in Secondary 4 and 22 in Secondary 5) in a Hong Kong secondary school were involved. Flipped classroom was adopted to teach students about computer programming topics (conditional, repetition and array) in both classes. Data were collected from a questionnaire and two interview sessions to explore students' views on using flipped classroom to learn computer programming. The findings of this study indicate that students in the flipped classroom, regardless of their performance level, experienced stronger grasp of programming knowledge and higher engagement in learning programming concepts. Our findings also highlight limitations with this study that could be addressed in future work.

Keywords: Flipped classroom · Computer programming · Learning and teaching · Secondary education

1 Introduction

Due to the prevalence of digital devices and a growing demand amongst the public for software applications in recent years, computer programming (often referred to interchangeably as coding) is fast becoming a core competence to meet the needs of the society of the 21st century. It was found that computer programming could potentially develop students' problem-solving skills [1]. However, it was also found that it could

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be challenging for students to grasp the knowledge and skills they need to develop simple text-based programs [2, 3].

In recent years, a major boost in the popularity of computer programming education has come with the invention of free visual programming environments such as Scratch [4], Kodu [5] and App Inventor [6]. These environments enable students to drag and drop jigsaw-like blocks of code in order to design a program, which can lower the barriers to learning computer programming [7].

In the meantime, there has been an increasing awareness and support of flipped classroom in the education community [8]. Flipped classroom is characterized as making effective use of Information and Communication Technology (ICT) to provide learning materials to students for self-study at home ahead of classes, while homework assignments are undertaken as learning activities during classes [9]. Given this arrangement, more class time can be devoted to active learning activities and less to direct teaching. This would create a more student-centered learning environment where students are engaged in the constructivist learning process and teachers can act as facilitators to assist students in the process.

In the flipped classroom, students are often given access to online video lectures before classes start. Students can benefit from watching the online lectures out of class because they are able to control their learning pace to suit their own needs and to better understand the content. During classes, students are able to participate more in a variety of learning activities (e.g. problem-solving tasks, discussions and debates). They are also able to receive teacher feedback on their class performance more frequently [10, 11].

While there is a growing body of research into the effects of flipped classroom on second language learning in higher education [12, 13], scant attention has been accorded to the use of flipped classroom in computer programming education, especially at the secondary level. To fill the gap, this study was designed to explore students' views on using flipped classroom to learn computer programming in secondary education. Specifically, it aimed to identify the effects of flipped classroom on students' learning and acquisition of programming knowledge and skills.

2 Research Method

2.1 Research Design

This study adopted the design-based research approach [14] to explore the use of flipped classroom in computer programming education. The approach features an iterative, cyclical process of testing and refinement of problems, solutions, methods and design principles so as to investigate a research question. It is widely used for the conceptualization and implementation of an educational innovation in natural settings, as well as for a better understanding of how and why the innovation works in practice.

There were three design-based research cycles in this study, each cycle comprising two teaching experiments – one experiment for a Secondary 4 class (S4) and the other for a Secondary 5 class (S5) (see Fig. 1). Both classes were taught by the same teacher. The programming topics covered in the experiments were conditional (e.g. if-then-else statements), iteration (e.g. while loop and for loop statements) and array. The duration of the whole study was around 4 weeks, with each week comprising of two 35-min lessons. Prior to the study, a set of teaching plans (including learning topics, levels of study, estimated study time, in-class and out-of-class activities and learning resources) were set out. A sample teaching plan for two consecutive lessons is illustrated in Table 1. In each experimental cycle, the teaching plans were executed to implement flipped classroom and they would be revised to take into account the observations made by the class teacher.

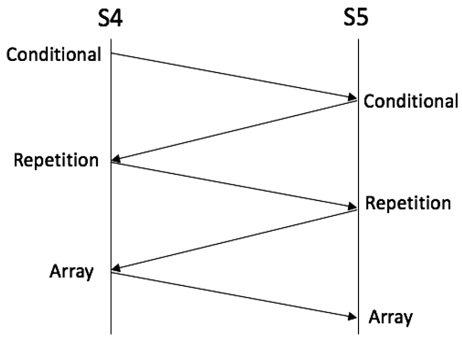

Fig. 1. The three design-based research cycles in this study.

Table 1. A teaching plan for two consecutive lessons.

Topic	Level of study	Out of class	In class
Conditional (if-then-else)	Secondary 4	Estimated time: 40 min Self-study topics: • Boolean values and operators (e.g. True, False, > , <) • AND, OR operations • Syntax of Boolean operators Activities: Application of the Boolean operators into several tasks Learning resources (code.org): • Online video lectures (3 video clips) • Online self-tests with instant feedback	Estimated time: 70 min Activities: • The teacher gives a quick review on Boolean values and operators • The teacher gives a short demonstration on using Boolean values and operations to solve simple problems • Students apply the knowledge and skills on Boolean into a more complicated task Teacher observations: • Many students could complete the task on their own, with minimal teacher guidance • More class time was used to cater for individual learning differences

Drawing on the technology acceptance model [15], a questionnaire was designed to assess students' general attitudes towards using flipped classroom to learn programming, as shown in Table 2. The questionnaire contains 4 statements and its response options are based on 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). It was administered to all participants at two points of time: the start of the first cycle and the end of the last cycle. Subsequent to the completion of the post-questionnaire, a purposive sample of high- and low-achieving participants were invited to attend focus group interviews to seek their further detailed views on using flipped classroom to acquire knowledge and skills about programming.

Table 2. A questionnaire for assessing attitudes towards flipped classroom in programming.

Item code	Item
I1	Learning programming through flipped classroom is a good idea
I2	Learning programming through flipped classroom is a wise idea
I3	I have no difficulty in accessing and viewing online materials for learning programming
I4	I will use flipped classroom for learning programming in future

2.2 Participants

Forty students from a Hong Kong secondary school accepted the invitation to participate in this study. They were all enrolled in the ICT subject during the second semester of 2016/17. They came from two different classes, 18 students (10 males and 8 females) in Secondary 4 and 22 students (10 males and 12 females) in Secondary 5. Their ages ranged from 15 to 17 years with a median of 16 years. At the outset of this study, all participants had already acquired basic concepts in simple programming sequence but had no ideas about some more advanced topics like conditional, repetition and array. They gave informed consent in writing before taking part in this study.

2.3 Data Collection and Analysis

Before each lesson, participants were asked to self-study parts of a programming unit namely 'Intro to Programming' at code.org. The unit covers the basics of using JavaScript to design and build interactive applications. It was chosen as the learning materials in this study because JavaScript is one of the key topics in the ICT syllabus of the Hong Kong Diploma of Secondary Education Examination (HKDSE). Figure 2 shows a screenshot of the programming unit.

During the lesson, the class teacher gave a quick review of the online learning materials and a short demonstration of core programming skills to ensure that all students understood what they were expected to know before moving forward to class activities. A few students might not spend time on online learning before class, so they would be asked to study the online materials first and then attempt exercises in class. Class exercises were designed to assess whether students could effectively apply what

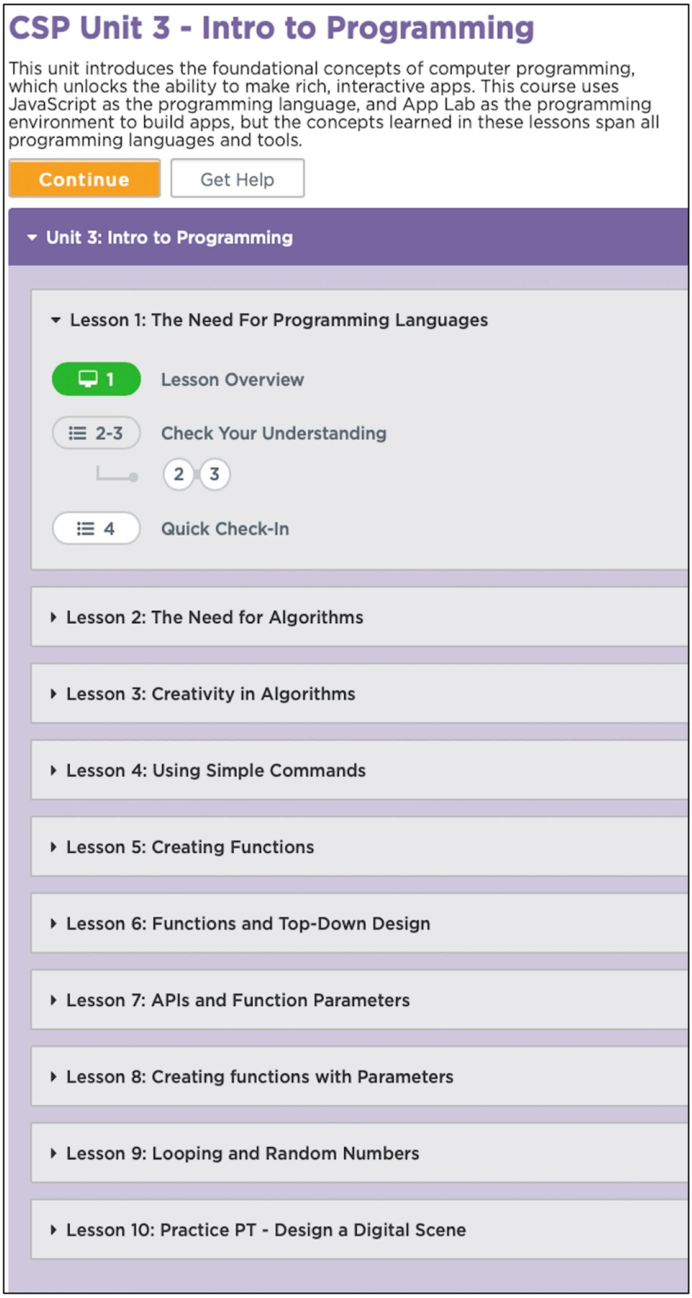

Fig. 2. A screenshot of the programming unit at code.org.

they had learned into a practical situation. Students were required to complete all class exercises on an individual basis. Their answers to the exercises were marked and feedback was given by the teacher. The exercise scores were counted in the overall course assessment. A sample class exercise is illustrated in Fig. 3.

Programming Exercise – Conditionals and Loops

Write a JavaScript program to compute the average marks of the following students. Then, the program will use the average marks to determine the corresponding average grade of the students.

Student Name	Marks
Apple	80
Bob	95
Calvin	77
Desmond	88
Evan	68

The grades are computed as follows :

Range of Marks	Grade
< 60	F
< 70	D
< 80	C
< 90	B
< 100	A

Fig. 3. A sample class exercise.

After completion of the experimental lessons, participants were categorized into high- and low-performing groups based on their performance in class exercises. Two focus group interview sessions, one for Secondary 4 and the other for Secondary 5, were conducted with a purposive sample of high- and low-performing participants. There were altogether 8 interviewees (4 interviewees from Secondary 4 and 4 from Secondary 5). The interviews were audio-recorded, transcribed verbatim, summarized and thematically categorized using thematic analysis [16]. The interview protocol initially consisted of the following key questions: Do you agree that flipped classroom is effective in supporting students to learn computer programming in secondary education? Follow-up probes and questions (like 'why', 'when', 'how' and etc.) were asked to elicit further details of the respondents' views.

3 Results and Discussion

3.1 Questionnaire Results

This section analyzes the questionnaire data to explore students' general attitudes towards learning computer programming through flipped classroom. Table 3 summarizes the descriptive statistics and *t*-test results of the questionnaire administered to participants at the beginning and the end of the study. It can be seen that students' pre-ratings on all items are approximately between 3 and 3.4 (I1: 3.361, I2: 3.057, I3: 3.286, I4: 3.417), showing that students appeared to neutral with respect to using flipped classroom to learn programming at the outset of the study. In contrast, it can be found that students' post-ratings on all items are approximately between 3.3 and 3.7 (I1: 3.583, I2: 3.314, I3: 3.714, I4: 3.694). The results indicate that students tended to be positive with respect to using flipped classroom to learn programming after the implementation of flipped classroom.

Additionally, Table 3 shows a statistically significant difference between the pre-rating and post-rating on I3. This result suggests that flipped classroom can likely influence students' perceived ease of access of online learning materials about programming. Table 3 also shows that there is an increase from the pre-rating to the post-rating on each of the remaining items (I1, I2, I4). Even though the increases in ratings were not statistically significant, they could reflect that students held more positive attitudes towards using flipped classroom to learn programming when they had experience in doing so.

Table 3. Descriptive statistics and t-test results of the pre- and post-questionnaire.

Item code	Pre-rating	Post-rating	*t*	*df*	*p*
I1	3.361	3.583	1.244	35	0.222
I2	3.057	3.314	1.717	34	0.095
I3	3.286	3.714	2.766	34	***0.009****
I4	3.417	3.694	1.711	35	0.096

$^*p < .05$ (2-tailed)

3.2 Interview Results

This section analyzes the interview data to explore the effects of flipped classroom on students' learning and acquisition of computer programming knowledge and skills. The interview results of this study indicate that students generally agreed that flipped classroom is effective in supporting students to learn computer programming. Most of the interviewees said that flipped classroom could support them to learn at their own pace. They explained that they could revisit the learning materials at home to have stronger grasp of more advanced topics in computer programming. As the following interviewees said:

> "*When I was watching the video lectures on computer programming at home, I could pause and replay the lectures as many times as I needed. This could help me better understand difficult concepts like looping and array.*" (Interviewee A, Low-performing, Secondary 5)

> "*I did not fully understand how to use array and had many questions when I watched the online video the first time. But after watching the video 2 to 3 times, I got a better understanding of the concept.*" (Interviewee C, High-performing, Secondary 4)

Some interviewees reported that flipped classroom could enhance the whole-class interactions between teacher and students. With flipped classroom, they thought that they had more opportunity to participate in hands-on programming activities in class. These class activities provided a good context in which to ask questions, to discuss with peers and to seek assistance from the teacher. This point is echoed by the following quotes:

> "*I think that programming needs practice and guidance … Even though I encountered problems in making a computer program at home, I could obtain guidance and support from my teacher and classmates during the lessons.*" (Interviewee D, High-performing, Secondary 5)

> *"I did encounter problems when working on the programming exercises in class. However, I got help from teacher to solve the problems."* (Interviewee B, Low-performing, Secondary 4)

Additionally, it was commented that flipped classroom could sustain student engagement in learning computer programming. This is in part due to the effects of collaborative learning and high-quality multimedia learning resources. The following quotes illustrate this point:

> "*Yes, I enjoy using flipped classroom to learn programming because I can have more time to work with my classmates on programming exercises."* (Interviewee D, High-Performing, Secondary 4)

> "*Flipped classroom encourages me to learn programming. I think that it is not a good idea for the teacher to explain programming concepts in the lesson. I prefer watching video lectures because they are much easier to follow and understand.*" (Interviewee B, Low-performing, Secondary 5)

On the other hand, a few interviewees responded that flipped classroom may distract student learning. This issue is elaborated by the following quote:

> *"It is not always easy to concentrate on my online study at home. There are so many online distractions like games and social media that draw your attention away from learning."* (Interviewee B, Low-performing, Secondary 4)

> *"I know that playing Facebook or Instagram is enough to cause a distraction that can influence the effectiveness of my online learning, but it is hard to control myself not to play them at home."* (Interviewee E, High-performing, Secondary 5)

4 Concluding Remarks

This study aimed to explore students' views on using flipped classroom to learn computer programming in secondary education. Our findings indicate that students generally have positive attitudes towards learning computer programming through flipped classroom. When compared with traditional classroom instruction, it is found that the use of flipped classroom is effective in supporting students to learn computer programming at their own pace, promoting class interactions between teacher and students, as well as sustaining student engagement in learning computer programming. However, it is also found that flipped classroom can have an adverse effect on computer programming education because student learning at home may easily be affected by online distractions like games and social media.

The major limitation of this study is that the results of this study were drawn from a limited data set obtained over a short period of time. Future work can collect and analyze more data to allow for an in-depth understanding of student views on using flipped classroom to learn computer programming. Furthermore, the effects of flipped classroom on computer programming achievement can be examined.

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Enhance Lower Secondary Students' Scientific Literacy and Conceptual Understanding of Tonicity Through Blended Learning

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Abstract. Common difficulties for learning biology, for example, imagination of microscopic phenomena, integration of multiple concepts and understanding of technical terms, have long existed across educational levels. These challenges do not only make biology less approachable, but also affect students' scientific literacy. Hence, this study aims to develop a blended learning activity consisting of digital media and a card game to support student understanding of tonicity as well as promote scientific literacy. Digital media are developed to visualise and conceptualise the microscopic mechanism of tonicity, which is expected to be less time consuming and more engaging. In addition, a card game activity that includes multiple concepts, pictorial representations and technical terms on tonicity is developed to promote abstract understanding among learners.

Keywords: Blended learning activity · Scientific literacy · Tonicity · Card game

1 Introduction

The concept of tonicity involves a range of sub-topics such as concentration gradient, transport across the membrane, diffusion and osmosis, all of which form an important part in general biology as well as general science in both Thailand and worldwide. According to Basic Education Core Curriculum B.E. 2551 (A.D. 2008) of Thailand [12], it is indicated that students are required to learn about this integrative concept (indicator 4, standard 1). In addition, this topic is fundamental to explain other biological concepts such as the opening and closing of stomata in plants, sugar diffusion in plant cells and absorption water in the root and aerobic cellular respiration, photosynthesis, absorption and assimilation in plants and animals.

There are various teaching methods of this concept. First, pictorial explanations are used generally in textbook to visualise the concept alongside detailed explanations. Second, laboratory is used to allow students to explore the phenomenon by using potatoes or beetroots which are soaked in different solutions. Third, others may use animation software as a teaching tool to show the microscopic level of the biological mechanism that helps students explore the movement of molecules more clearly. Additionally, there are online materials in the form of games that teach osmosis to

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primary school students. However, there are no educational games on this topic available in the academic literature.

Although there are various ways for this topic to be delivered, it remains difficult to many learners, especially younger students. This may be due to the fact that it represents the microscopic level of biological phenomena and thus requires student imagination. Moreover, the sense of integration of multiple scientific concepts in one topic makes it challenging to students to gain overall conceptual understanding, not to mention a huge extensive memorisation of technical terms. Based on the textbook which developed from Institute for the Promotion of Teaching Science and Technology (IPST), there are numerous words that required for school students to remember and understand during the 3 years of the lower secondary education. On top of this, these languages are foreign to learners (Latin or Greek-rooted terms) and that makes them struggle [2, 14]. This challenge causes struggling effect to students' science literacy, making learning that involves listening, interacting, speaking, understanding texts, and creating texts less possible to average learners [10].

Hence, this study aims to develop a blended learning activity consisting of digital media and a card game to support student understanding of tonicity as well as promote scientific literacy.

2 Literature Review

2.1 The Concept of Tonicity

Tonicity describes the ability of extracellular concentrate solution to move water molecule in and out of a cell by osmosis which is the water net movement process through selective membrane from an area of lower solute particles per litre of solution (low osmolality) to an area of higher solute particles per litre of solution (high osmolality). When total solution outside and inside of cell differentiation and two areas have separated by a membrane permeable to water, but not to solute, water will move from the lower side of solute (low osmolality) compartment to higher side of solute (high osmolality) compartment.

2.2 The Significant Role in the Science Curriculum

It is indicated in the national standard that students are expected to develop understanding of the transport of materials across cell membranes because learning of concentration and tonicity processes of diffusion and osmosis, is fundamental to understanding of other biology concepts [9].

According to Basic Education Core Curriculum B.E. 2551 (A.D. 2008) of the 7th grade, it indicates that students should be able to do the experiment and explain the processes of passing substances through cells by diffusion and osmosis [12]. Moreover the standard science curriculum in Thailand, cell transport is a basic topic to explain other concepts in grade 7 such as water vapour in plants due to diffusion of water from stomata into the air via transpiration, sugar diffusion in plant cell and absorption of water in root cells [12]. In grade 8, the concept is fundamental to understanding of gas exchange in the lungs, tissues and food digestion. This concept is also taught at a high school level as both diffusion and osmosis are prerequisite for aerobic respiration, photosynthesis, absorption and assimilation in plants and animals.

2.3 Student Difficulty in Learning This Concept

Diffusion and osmosis are difficult to learn because both concepts require students to understand a microscopic level of the mechanisms [4]. Many have trouble imagining the molecular mechanisms related to movement of substances across the cell membrane [5]. Apart from requiring students' imagination, the sense of integration of multiple concepts into one unifying topic in biology. To understand how diffusion and osmosis occur, it is important to understand a physics concept involving dynamic equilibrium (different concentrations on each side of a membrane). In addition, it requires a great deal of understanding of chemistry in relation to solution (solvent, solute) and concentrations [3]. On top of such complications, according to Thailand's standard science textbooks, lower secondary students are expected to remember and understand the essential technical terms which have Greek originated prefixes. It demands time for young students to remember and later make sense of the terms to develop better understanding [12].

2.4 Teaching Methods of This Concept

According to literature, there are various teaching methods of this concept. First, pictorial explanations are generally used in textbooks to visualise the concept alongside detailed explanations. Second, laboratory is used to allow students to explore a phenomenon by using potatoes or beetroots which are soaked in different solutions. Third, others may use animation software as a teaching tool to show the microscopic level of the biological mechanism that help students explore the movement of molecules more clearly. Additionally, there are online materials in the form of games that teach osmosis to primary school students, but none has existed to teach secondary school students.

2.4.1 Textbooks – Pictures

Based on a standard science textbook for seventh graders in Thailand developed by Institute for the Promotion of Teaching Science and Technology (IPST), cell transportation is detailed with pictorial presentations indicating movements of water and solutes. In this topic, students will learn about the processes of passing substances through cells without using energy by diffusion and osmosis. Although, this allows students to see the movement of particles that diffuse from the area with higher concentration to lower concentration, it is still challenging for students to imagine what would happen in a microscopic level and how to apply this to real life situations.

2.4.2 Laboratory

A number of laboratories have been designed for students to investigate diffusion and osmosis. For example, students can explore changes happened to sliced potatoes or beetroots that are soaked in solutions with different concentrations for a certain period of times [13]. Some may use dialysis bags instead of sliced potatoes or beetroots [4].

In this form of experiments, students are able to observe changes in weight of sliced potatoes or beetroots or solutions left in dialysis bags after being soaked in various solutions which allow them to conceptualise the direction of water osmosis in different concentrations of solution [13]. Another work suggests to use living cells (skin of a red onion, *Elodea,* red blood cell from a cow) soaked into different solutions to make the experiments more exciting under the microscope [8].

However, the microscopic mechanism still has to be imagined by students themselves or has to be shown using other tools such as animations, for example, a molecular modelling software was developed [4] which can help students visualise the molecules level more clearly. Moreover, although students can tangibly see what occurs, it demands a great deal of time which takes over 24 h to complete this experiment and might not be able to let students imagine what happens in a microscopic level even they used molecular software to visualise it.

2.4.3 Game

There is a mobile game that teaches the process of water moving in and out of the cell called "Osy osmosis". This mobile game was developed by a group of researchers, educators and software designers of the University of Georgia. While playing this game, learners can see the movement of water in and out of the cell which depends on the environment surrounding which keeps the cell intact. Since the aim of the mobile is to educate primary students about osmosis, it is not possible to use it to display more complicated phenomena being studied by middle school students. Therefore, there is a need to develop an educational game which can be used to learn about osmosis, diffusion and tonicity.

3 Developing a Blended Learning Activity

The aforementioned teaching approaches, once stand alone, show various limitations. Textbook-based teaching is rather passive and less engaging. Laboratories seem to engage students conceptually and are able to make the microscopic mechanism of osmosis more tangible with concrete evidence. However, it demands a great deal of time to spend for a single experiment. In addition, educational games like board games, card games and mobile games, are promising to engage students of this present day. However, none has been reported to promote middle school students to understand the concept of tonicity. Therefore, this paper proposes a blended learning activity in which pictorial presentations (as used in textbooks) will be integrated in a form of card games. Also, a laboratory will be recorded as a video file, a form of digital media, to speed up the time to see physical changes within an appropriate amount of time.

3.1 Digital Media

The video has been a vast majority for blended courses. A study has shown that using technology can enhance student's achievements in learning than not using technology [11]. Furthermore, several studies have shown that video is a highly effective educational tool [1, 7], not to mention its simplicity to produce and use.

This digital media aims to include a speed up version of the osmosis experiment in which sliced potatoes are placed in a solution with various concentrations [4]. Normally, students can observe changes in weight of the sliced potatoes in interval. However, it takes up to 24 h to be able to observe significant changes. Therefore, this developed activity will produce a time-lapse video recording physical changes over 24 h to make it done within 5 min. It is suggested that engagement time for watching videos should be no longer than 6–9 min [6]. The aim of this part is to raise students' curiosity about the microscopic phenomena related to this occurrence which shall be further explored in a card game activity. It is believed that by watching this video, students will gain understanding of the phenomena from a macroscopic level (what they can obviously see) as much as they would do the experiment themselves. This macroscopic change may prompt them to explore more deeply in relation what occurs in a microscopic level.

3.2 Card Game

The students are allowed to participate in a card game activity that includes the learning of multiple concepts and technical terms on tonicity. The card game is developed to deliver the concept of water movement (osmosis) across the cell through the cell membrane and the effect of water movement that changes the cell's content and form. In this game, two groups of pictorial presentations will be incorporated. One represents concentrations of solutes inside and outside the cell. In this type of card, students can easily count the number of solute molecules and compare the concentration between inside and outside the cell. The higher number of the solute molecules, the higher the concentration of the solution. This will help them to be able to determine the direction of water movement. The other represents different appearances of cells composing of both plant and animal cells. This type of cards will help students see what changes could appear after water moves in or out the cell. In addition, they are able to see the difference between plant and animal cells after such microscopic mechanism occurs.

The rule of the card game can be as simple as the keep the shape of the cell intact, meaning to keep the solution isotonic. Therefore, students who play will have to try to keep the concentration between inside and outside the cell equal. If they cannot do so, they have to change their cell to the form that is corresponding to the movement of water. For example, if it happens that they cannot keep the balance between inside and outside, but get a lower concentration in the outer part of the cell, which represents a hypotonic solution. If this is to happen, they will have to change the cell form to be a swollen form. The winner is the player who can collect the most isotonic solution cards and has less of other cards and is the one who gets a reward. It is believed that while playing students are able to observe the relationship between the concentration of the solution and the result of cell changes which in turn helps them to determine the direction of water movement that relates to such changes.

4 Conclusion

Tonicity is a scientific concept that is compulsory for middle school students in Thailand to study. It is fundamental to other complex concepts in biology such as the opening and closing of the stomata, transpiration, gas diffusion and so on. In addition, it is related to other physics and chemistry concepts such as concentration gradients and osmolarity pressure. There have been various instructional approaches for delivering this topic such as passive teaching based on textbooks using pictures, laboratories and game. However, textbook-based teaching is rather passive and less engaging. Laboratories seem to engage students conceptually and are able to make the microscopic mechanism of osmosis more tangible with concrete evidence. However, it demands a great deal of time to spend for a single experiment. In addition, educational games like board games, card games and mobile games, are promising to engage students of this present day. However, none has been reported to promote middle school students to understand the concept of tonicity. Therefore, this paper proposes a blended learning activity in which pictorial presentations (as used in textbooks) will be integrated in a form of card games. Also, a laboratory will be recorded as a video file, a form of digital media, to speed up the time to see physical changes within an appropriate amount of time. It aims to make this complicated concept more approachable. In addition, it aims to build abstract understanding of the microscopic phenomena through the use of media and card game. The current stage of this work is in progress. It seeks to develop a blending learning platform for this concept. It aims to also propose a lesson plan once the activity is properly formed. Furthermore, it aims to evaluate students' development of conceptual understanding of the concept as well as scientific literacy after the activity is implemented.

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How Teachers' Support Affects Learners' Participation in Blended Learning

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Abstract. Numerous studies have shown that blended learning is an effective modern learning method. Teachers, as the guides in online learning and monitors in the classroom, play an increasingly important role in blended learning. In order to study the influence of teacher support behavior on learners' learning activities in blended learning, this paper took the Liru online courses "Practice of Distance Education" as an example to carry out empirical research. The overall research idea is to divide the teaching activities into three modules: autonomy learning activities, interactive learning activities and expanding learning activities, Then, 43 undergraduates who study the course are recorded and analyzed in the Liru online courses for one semester of learning behavior data. By analyzing the teachers' support in various teaching activities, the impact of teacher support on the learning participation of learners in the various stages of teaching activities is explored. The analysis yields two main findings: first, in the self-learning activities, the access of students' resources is affected by the evaluation of teachers' performance. The frequency of the lecture materials that are closely related to the students' visits and tests is significantly more than other materials, such as learning introduction, teaching objectives and other materials; Second, the real-time interactive question conducted by teachers in classroom interactive learning activities can effectively promote students' active participation in learning activities.

Keywords: Blended learning · Teachers' support · Learning activity · Learning participation

1 Background

The traditional teaching method of indoctrination in classroom emphasizes the teacher's main role unilaterally. Teaching is entirely centered on the 'teaching' of the teacher and seldom considers 'learning' of the student from the student's point of view. In this case, students as cognitive subjects have less opportunities to participate in teaching activities, and are in a passive state from beginning to end. Their initiative and enthusiasm are difficult to play. It can neither guarantee the quality and efficiency of teaching, nor foster students' divergent thinking, critical thinking and creative thinking, nor is it conducive to the growth of creative talents (He 1997). This form of teaching has always been criticized by people. In online learning, the separation of time and

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space between teachers and students emphasizes "student-centered" and ignores the leading role of teachers. This leads to a series of bad phenomena in online learning, such as low completion rate of courses, poor autonomy of students, shallow negative participation, low contribution and sharing of resources.

Blended learning, as a neutralizer of online learning and classroom teaching, combines the advantages of traditional learning methods and online learning. It not only plays the leading role of teachers in guiding, inspiring and monitoring the teaching process, but also fully reflects the initiative, enthusiasm and creativity of students as the main body of the learning process (Kekang He 2004). Blended learning is not only a mixture of on-line and Off-line in form, but also a mixture of different teaching models based on different teaching theories (such as constructivism, behaviorism and cognitivism), teacher-led activities and student-centered participation, classroom teaching and online learning in different learning environments, and different teaching. Media mixing, classroom teaching and virtual classroom or virtual community mixing, etc. (Cai 2016). At present, there is a consensus in international educational technology circles that only by combining traditional classroom teaching with online learning and making their advantages complementary, can we achieve the best learning effect.

2 Relevant Studies

At present, the research on the effect of learning mainly includes the following aspects.

Firstly, it explores the influence of different learning environments on students' learning effect. For example, Lin (2014) designed the learning mode of micro-lesson under the ubiquitous learning environment, and designed and verified that the learning mode has a positive impact on optimizing the learning process, improving students' knowledge mastery rate and improving students' learning effect. Chen (2013) compared the difference of the effect of blendeed learning and online learning on students' learning. The results show that on the whole, blended learning is more conducive to improving and improving students' learning effect than pure online learning and face-to-face learning. Wang et al. (2017) have studied the influence of touch interaction and mouse interaction on learning effect of learners of different ages in digital learning environment. The experimental results show that there are significant differences in learning effect among learners of different ages. The learning effect of college students is obviously better than that of middle school students, and this advantage is particularly prominent under the touch interaction mode. Wang et al. (2015) have studied the effects of four types of media combinations on the learning effect of college students in the multimedia learning environment, namely, the separation and combination of pictures and texts, the close combination of pictures and texts, the combination of pictures and sounds and the combination of single words. Among them, the combination of pictures and sounds is better than the combination of single words, and the combination of pictures and sounds is better than the combination of pictures and texts. Therefore, in the multimedia teaching environment, the reasonable arrangement of media presentation will help learners to acquire learning content and improve learning efficiency. Cai (2016) studied the influence of different teaching methods on students' learning effect in creator education, and concluded that under the guidance of teachers, cooperative learning was the best way to achieve learning effect. Therefore, it is considered that cooperative learning is a very suitable teaching method for creator education.

Secondly, from the perspective of students, this paper studies the influence of students' individual behavior on students' learning effect. Zong et al. (2016) analyzed the influencing factors of MOOCs learners based on the overall learning process of MOOCs learners, taking students' performance as the evaluation index of learning effect. The study found that students' behaviors such as the time lag of course registration, the number of courses registered, the number of homework tests submitted, the number of exercises saved and the degree of video viewing completion were significantly correlated with their scores. Koutropoulos et al. (2012) classified learners into three categories according to their participation in the course and explained the characteristics of each type of learners and their corresponding learning performance: Lurking Participants generally do not interact with their peers, only follow the course progress, view teaching materials, teaching videos, participate in tests, and the learning effect is poor; Moderately Active Participants will participate in the course. Participating in some interesting topics, the learning effect of small-scale discussion is better than that of divers (Lurking Participants); besides participating in topic discussion, active participants are good at summarizing and sharing learning experience, actively tapping curriculum-related knowledge and initiatively initiating topic discussion. Its learning effect is obviously better than that of divers and moderately active divers. Li and Zhang (2016) emphatically analyzed the influence of different types of students in engineering on learning effect. Tian et al. (2017) analyzed the influence factors of social interaction on learning effect in online learning process. The research shows that participation, sharing, trust and cognition in several dimensions of online learners' social behavior have a direct impact on learning effect, while network relationship and social learning motivation indirectly have an impact on learning effect.

Thirdly, from the teacher's point of view, the factors that affect students' learning effect are analyzed. The conclusion from literature research at home and abroad shows that teachers' participation and behavior, attitudes and expectations, teaching methods selection, learning task design and learning feedback all affect online learners' learning engagement. Liu et al. (2017) discussed the impact of teacher support on students' online learning engagement. Teacher support is divided into three dimensions: autonomous support, emotional support and cognitive support. The research concludes that, in terms of teacher support, autonomous support has the greatest impact on online learning input. Emotional support and cognitive support declined in turn. Fredricks et al. (2004) explored the relationship between teacher support and students' learning engagement in traditional teaching environment. The results showed that when students perceived teacher support, they tended to show higher input, thus enhancing the learning effect. Zhang and Li (2015) analyzed the direct or indirect influence of process learning evaluation on students' learning effect from two aspects: the frequency of process evaluation and assessment methods and the timeliness of feedback, and process learning evaluation mainly influenced students' learning effect by promoting good student-teacher interaction. This paper attempts to explore the influence of teacher support on guiding students to participate actively in learning activities and improving students' learning effect under the blended learning environment, with a view to giving some suggestions.

3 Learning Process

Based on the online learning platform of online course, this paper constructs an online learning environment, see in. By collecting and analyzing the data of teachers' and students' participation in the course "Application of Distance Education" in Liru online course, it explores the influence of teacher support on students' participation in learning process.

The course "Application of Distance Education" adopts a blended learning method combining online and offline learning. It permeates the concept of flipping classroom teaching. The process of teaching activities is divided into three modules. As shown in Table 1, pre-class autonomous learning activities, classroom interactive learning activities and after-class extended learning activities are included. Teachers' learning support behavior varies in different teaching activities (Fig. 1).

Table 1. Behavior of teachers and students in teaching activities.

	Student learning behavior	Teacher support behavior
Pre-class autonomous learning activities	Complete learning materials Complete the pre-class quiz raise a query	Providing learning materials Answer students' questions Pre-class quiz evaluation
Classroom interactive learning activities	Discussion and communication Collaborative learning	Organize discussion and exchange Organizing collaborative learning Monitoring classroom Give feedback, guidance
Extending learning activities after class	Reading expansion materials Exchange and discussion after class	Providing outward bound learning materials Provide after-school learning support

(1) Pre-class Autonomous Learning Activities

Students' autonomous learning activities are carried out in the online environment. Teachers and students are separated in time and space. Students must learn the learning materials provided by teachers before class and complete the test exercises. At the same time, the confusion and problems existing in the learning process are questioned through Confucian cloud platform, waiting for teachers' feedback. In this process, the number of teachers' feedback and the time interval will affect the number of students' questions and replies, and then affect the students' learning effect. By evaluating the students' pre-class tests, teachers can understand the students' learning situation, and then adjust the teaching plan to improve the teaching efficiency. And give solutions and help guidance to students' questions.

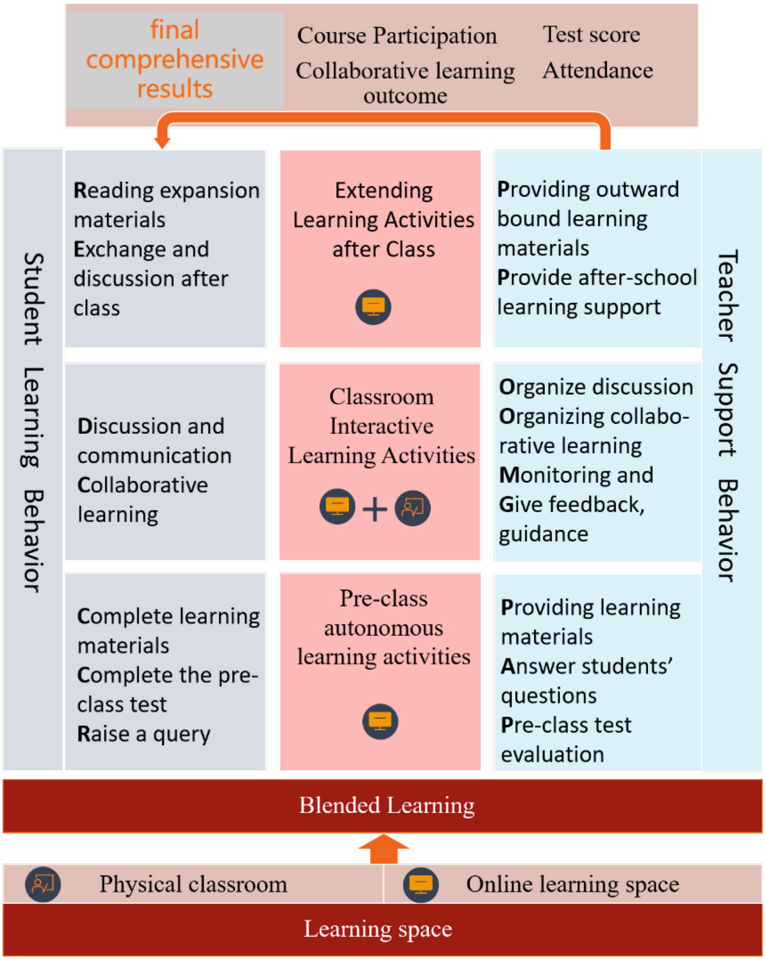

Fig. 1. Behaviors of students and teachers in a blended learning environment.

In the pre-class autonomous learning activities, the highest access of topics are quiz and PowerPoint learning materials. As shown in Fig. 2. On the one hand, as a procedural evaluation index of students, which is an external incentive, it is related to the final comprehensive results about students, so the views increase; on the other hand, because the content of the each quiz involves the knowledge points each lesson, which are reflected in the text materials of the learning materials, like PowerPoint. so students visit traffic of text learning materials increased. The results were consistent. Occasionally, when there are fewer views on learning materials, the analysis may be due to the simplicity of the quiz and the unrestricted times of answers, so that students can answer all the item through the past learning experience or repeated answers. In addition, the lack of supervision and incentive from teachers or peers in pre-class

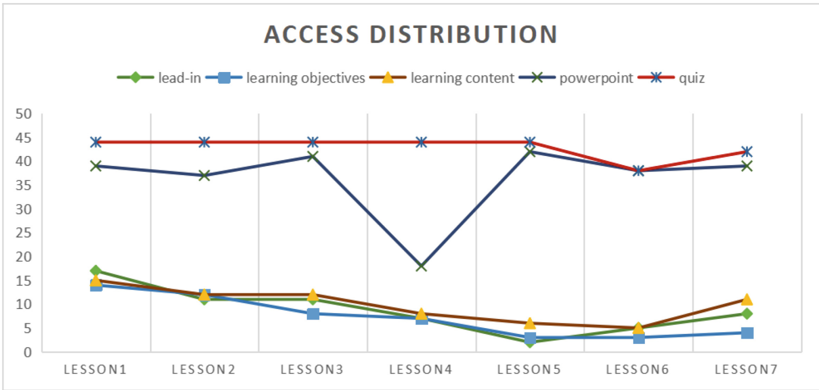

Fig. 2. Access of quiz and learning materials about students for each lesson.

autonomous learning leads to students' lack of autonomy and enthusiasm in learning, which leads to less visit traffic on resources and activities.

(2) Classroom Interactive Learning Activities

In classroom interactive learning activities, teachers and students are in the same blended learning environment. blended learning environment can make up for the shortcomings of single teaching and online learning, combine various elements of traditional classroom teaching and digital online learning organically, realizing the comprehensive advantages that a single teaching form does not have, and providing different teachers with optimal access to information, the best learning resources and flexible learning methods in teaching practice.

The purpose of interactive question-and-answer activities conducted by teachers in offline classroom teaching is to check up students' understanding and mastery about the current learning content, on the other hand, to enhance students' sense of learning participation and achieve a sense of learning achievement through teacher-student interaction. Figure 3 shows students' participation in real-time interactive question-and-answer in classroom interactive learning activities. The data show that in teacher-student interactive question-and-answer activities (non-compulsory student answers), more than half of students answered teachers' classroom questions in this real-time teacher-student interactive activity, and students participate well. Figure 4 is a real scene of students' online learning interactive communication activities under the supervision and guidance of teachers in a blended learning environment. From the picture, we can see that students have a high enthusiasm for participation. At the same time, the content of discussion and communication is rich and suitable for the learning content, see in Fig. 5. It can be seen that the students devote themselves to the learning activities wholeheartedly.

(3) Extending Learning Activities after Class

Extracurricular learning activities are carried out after class. At this time, unlike in classroom interactive learning activities, teachers monitor the whole teaching process, and lack of external conditions such as pre-class test evaluation or other conditions to continue to motivate students to study after class. Students' learning autonomy is poor,

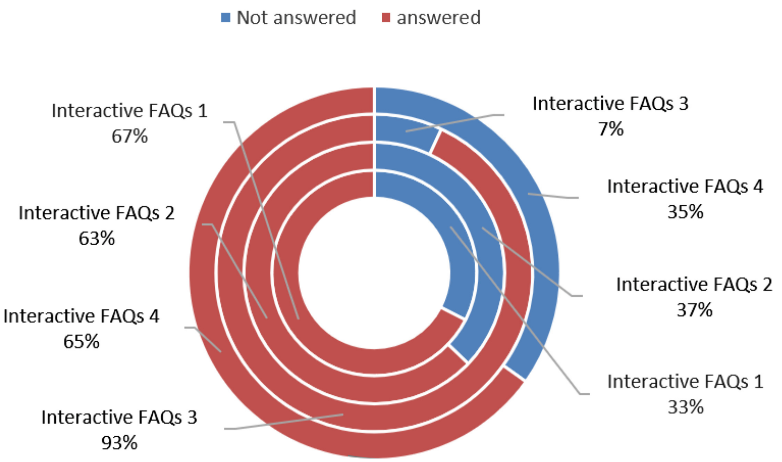

Fig. 3. Interactive question and answer between teachers and students in blended learning environment

Fig. 4. Teacher-student interaction in a blended learning environment

Fig. 5. Sample picture of interaction among students

self-control is weak, and teachers support feedback response time is longer, which seriously affects the interaction between teachers and students. Students' learning "loneliness" is enhanced. In the long run, students' enthusiasm for self-learning will be hampered and online learning time will be reduced.

4 Conclusions

(1) In autonomous learning activities, student resource visits are influenced by teacher performance evaluation.

In autonomous learning activities, students' resource visits are influenced by teachers' performance evaluation. The frequency of students' access to lecture materials closely related to the test is obviously higher than other materials, such as learning introduction, teaching objectives and so on. Therefore, students' internal motivation is an important factor affecting students' learning effect. In addition, external conditions can not be ignored. Necessary incentive and evaluation mechanism will also promote students to actively participate in learning activities. Especially in the online learning environment without teachers' supervision and control, teachers should not only actively interact with students and give feedback, but also design a perfect evaluation mechanism to help students to conduct online learning smoothly.

(2) Real-time interactive questions and answers conducted by teachers in classroom interactive learning activities can effectively promote students' participation in learning activities.

In online learning, the separation of time and space between teachers and students will lead to the "loneliness" of students' learning, and if there is no timely learning support from teachers, the enthusiasm of students' autonomous learning will be greatly weakened. In offline classroom teaching, real-time interactive questions and answers conducted by teachers have a significant impact on students' classroom participation. It can be seen that teachers' active interaction and participation can help students examine their mastery of the knowledge and help students consolidate their knowledge. Teachers' timely answers and feedback will also affect students' enthusiasm to participate in discussion and further learning. Teachers' timely feedback can not only answer students' doubts, but also stimulate students' enthusiasm to participate in learning activities, stimulate students to think positively, participate in teaching activities, and improve the quality of teaching.

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Effect of the Blended Learning Approach on Teaching Corpus Use for Collocation Richness and Accuracy

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Abstract. This study aims to explore whether the blended learning approach can be more effective in teaching students to use corpus for the purpose of collocation richness by pattern-hunting or for the purpose of collocation accuracy by pattern-refining. Two classes of students (n = 93) took part in the teaching experiment which lasted for 10 weeks. During which, students fulfilled pre-class assignments by using COCA (Corpus of Contemporary American English) to search for collocation on appointed words. Every pre-class searching task was followed with a sentence-making activity on Moodle forum, in which students were directed to post their writings and use corpus data as a reference to edit the language in their posts after considering feedback from 1Checker (a grammar checker), peers and the teacher. Analysis of students' written outputs found that: firstly, the pre-class trainings on searching for collocation of assigned words are beneficial in helping students to master and consolidate the corpus retrieval skills; secondly, the in-class sentence-making activities assisted by corpus have provided opportunities for students to apply the skills of pattern-hunting while writing the 1st drafts, and apply the skill of pattern-refining while conducting peer review or editing the 2nd drafts. Therefore, a tentative conclusion could be drawn that the blended learning approach is beneficial in teaching students to use corpus effectively for pattern-hunting and pattern-refining, aiming at improving the richness and accuracy of collocation in their writings.

Keywords: Corpus use · Blended learning · Collocation accuracy · Collocation richness

1 Introduction

Recent decade has witnessed an increasing consensus that hands-on corpus retrieval is beneficial for English as foreign language (EFL) learners (Chatpunnarangsee 2013; Kennedy and Miceli 2010; 2017; Li 2017; Yoon and Jo 2014, etc.), such as increasing students' learning motivation (Yoon 2011) by presenting them with real language

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(ibid), authentic learning context (Sinclair 2004) and "chunks" of language in use (Geluso and Yamaguchi 2014), etc.

In alignment with this consensus, many scholars have proposed direct corpus use by students in the classroom (Breyer 2011; Kennedy and Miceli 2010; 2017; etc.). However, teaching practices and researches on effective teaching method of direct corpus use by students are still limited (Kennedy and Miceli 2010; 2017; Li 2017), as many teachers are "still skeptical of the role of corpus-assisted teaching in contrast to traditional methods" (Li 2017). What's more, some of the previous researches have found that direct corpus use in the language classroom is less successful than expected (Breyer 2011; Kılıçkaya 2015; Tono et al. 2014).

Actually, one of the causes to the above-mentioned status quo lies in the fact that teachers and researchers have just simply added the online corpus retrieval task into the traditional classroom, rather than redesigning the whole teaching procedure by taking the features and demands of corpus retrieval into account (Bardovi-Harlig et al. 2017; Comelles et al. 2013; Crosthwaite 2017; Vyatkina 2016, etc.).

As a matter of fact, Graham (2006: 5) has defined this kind of combination of online learning and face-to-face learning as "Blended Learning", in which, students could be guided to fulfill pre-class self-directed learning activities and in-class interactive group learning activities to develop higher-order thinking abilities (Anderson et al. 2001; Hung 2015).

This study would redesign the teaching procedure to carefully integrate the online corpus retrieval tasks into the traditional classroom teaching, and explore whether the blended learning approach could be more effective in cultivating corpus retrieval skills.

2 Literature Review

2.1 The Blended Learning Design

Researchers have claimed that corpus could be introduced in class to help students solve language problems at any time (Yoon 2016) or both in and out of class (Furniss 2016). However, most previous studies tend to use it in or out of class exclusively and separately (see Crosthwaite 2017; Vyatkina 2016, Daskalovska 2015, etc.), lacking for cohesive alignment of online corpus retrieval and face-to-face teaching, which could be a distraction for students to complete given tasks (Kim et al. 2014).

To overcome the above-mentioned problems, the present study would use the blended learning approach that deliberately design the pre-class and in-class activities, would ensure the cohesion between the online corpus retrieval tasks and face-to-face activities. Considering that one of the challenges in blended learning design is facilitating the learning process (Boelens et al. 2017), we would provide the self-direct learning guides in detail to help students fulfill the tasks step by step, moving from lower-order thinking to higher-order thinking tasks gradually.

2.2 Corpus-Enhanced Collocation Richness and Accuracy in Writing

In concern with "collocation richness" in writing, Durrant (2009) have found that learners' writing shows repeated use of a small repertoire of collocations, in which they tend to overuse general terms and underuse terms that can indicate the degree of specificity. When it comes to the issue of "collocation accuracy" in writing, previous studies have suggested that collocation accuracy is one of the great challenges for EFL students (Schmitt 2010; Wray 2002). Therefore, it is of great importance to investigate how to help EFL students increase collocation richness and accuracy in their writings.

Wu (2015) found that corpus could be made use of to enhance both collocation richness and accuracy in EFL students' writing. However, pre-test and post-test surveys in her research were merely "collocation error correction" task with the help of COCA, which might not predict well how students would solve language problems encountered in their own writings. Therefore, the present study would invite students to complete real writing tasks, and apply corpus retrieval skills to solve their real language problems and thus meet their authentic needs (Gardener and Miller 2002: 15).

2.3 Corpus Retrieval for Pattern-Hunting and Pattern-Refining

It is noteworthy that the teaching of corpus retrieval skills aims at improving students' collocation richness and accuracy in writing. As one of the obstacles for introducing direct corpus use in classroom is "the difficulties that learners have in behaving like linguistic researchers when using corpus data (Kennedy and Miceli 2017)", Kennedy and Miceli (ibid) advocate to "*downplay* the learner-as-researcher notion" and put forward the "observe and borrow chunks" mentality, aiming at enabling students to make effective use of corpus to enhance their collocation in writing without demanding the same linguistic proficiency of a corpus-linguistic researcher.

In alignment with their "observe and borrow chunks" mentality, they introduce two ways of corpus retrieval: pattern-hunting and pattern-refining (see Table 1).

Table 1. Pattern-hunting and pattern-refining for collocation richness and accuracy

Retrieval method	Retrieval aim	Retrieval result	Application scene
Pattern-hunting	Open-ended	Collocation richness	1st draft
Pattern-refining	Specific	Collocation accuracy	2nd draft, 3rd draft, etc.

Table 1 indicates that the application of pattern-hunting starts with an open-ended retrieval aim, looking for suitable collocates to "enrich the content and language of a text", whereas the application of pattern-refining starts with a specific retrieval aim, looking for better collocates to "edit a text for lexico-grammatical accuracy" (ibid).

We would like to further clarify the application scene of Kennedy & Miceli's (ibid) two-way category. We believe that the pattern-hunting method could be mainly applied in improving collocation richness while writing the 1st draft of any text, whereas the pattern-refining method could be mainly applied to improve collocation accuracy in both of the peer review activity and the self-editing work while writing the 2nd draft, 3rd draft, etc. (see Table 1). It might also be noted that students should be instructed and encouraged to rely on corpus data to provide suggestions for improvement while completing peer review work, hence making their feedbacks trustworthy and convincing. In addition, students should also be directed to form a habit of retrieving corpus for confirmation before adopting suggestions from grammar checker, peers and teacher.

Therefore, this study would explore whether the blended learning approach could be more effective in teaching students to use corpus for the purpose of collocation richness by pattern-hunting while writing the 1st draft, as well as for the purpose of collocation accuracy by pattern-refining while conducting peer review or editing the 2nd draft.

3 Methodology

3.1 Research Question

Research question of the present study is: Can the blended learning approach teach EFL students to use corpus effectively to improve collocation richness and accuracy in their writings? Specifically, this study explores the following three questions:

(1) Is the blended learning approach effective in teaching the corpus retrieval skills?
(2) Is the blended learning approach effective in enabling EFL students to master the skills of pattern-hunting for the purpose of collocation richness in writing?
(3) Is the blended learning approach effective in enabling EFL students to master the skills of pattern-refining for the purpose of collocation accuracy in writing?

3.2 Participants

Two classes of first year undergraduate students (n = 93) took part in the teaching experiment which lasted for 10 weeks. They were non-English majors and none of them had prior experience with corpus.

3.3 Research Instruments

The research instruments in the present study were five pre-class corpus retrieval tasks, and five in-class sentence-making tasks. The pre-class tasks aim at developing students' lower-order thinking ability, especially the ability of retrieving the corpus of COCA in the purpose of pattern-hunting (see the pre-class task design in Appendix A); while the in-class tasks try to cultivate students' higher-order thinking ability, especially the capability of corpus use for pattern-refining based on automatic feedback from 1Checker, peer reviews and teacher feedback as well (see the in-class task design in Appendix A).

3.4 Experimental Procedure

The teaching experiment was integrated into a College English course (80 min per week), which is responsible for developing college students' English reading and writing proficiency. The teaching experiment contained five blended learning sections on cultivating corpus use for collocation richness and accuracy (see Appendix A for exemplar of the teaching procedure), lasting from Week 2 to Week 11 in the fall semester of 2018—every two weeks makes a blended learning section.

During which, students would spend 20 min in the first week completing the corpus retrieval task on appointed words/phrases (see Appendix A for task directions on pattern-hunting), and spend another 20 min in the following week to fulfill corpus retrieval work on personalized words/phrases while participating in the sentence-making activity held on the Moodle forum in the face-to-face section (see Appendix A for task directions on pattern-hunting and pattern-refining). It is noteworthy that the appointed keyword for the sentence-making activity is in alignment with the appointed corpus retrieval word(s) in the pre-class tasks, providing considerable support for students' sentence-creation work.

3.5 Data Collection and Analysis

Data were collected from three aspects: (1) students' corpus retrieval findings on the pre-class tasks were collected and analyzed to evaluate students' mastery of the corpus retrieval skills (including capability of interpreting the concordance lines). (2) students' 1st drafts from the sentence-making activities in class were collected to analyze how they have improved collocation richness of their writings by conducting pattern-hunting with COCA. (3) students' records on peer review and 2nd drafts were collected to analyze how they have improved collocation accuracy of their writings by pattern-refining.

4 Result and Discussion

4.1 Development of Students' Corpus Retrieval Skills

Students' performance on the pre-class tasks show that they were gradually developing the basic corpus retrieval skills by following the directions to enter specific "research command", study the concordance lines carefully and excerpt five concordance lines as required. However, problems were quite obvious at the 1st and 2nd pre-class tasks. Some of the malpractices were:

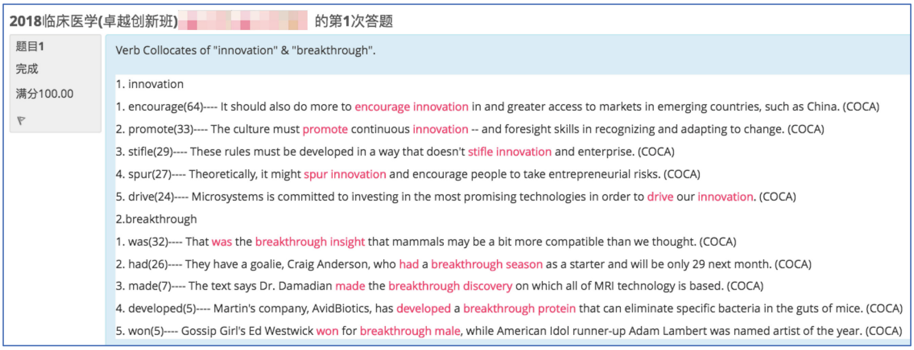
(1) Not being able to interpret the structure of the concordance lines correctly. For example, some students quoted such a sentence to illustrate the usage of the appointed phrasal verb—experiment with: "As the *experiment with* mice showed, the neuronal damage starts well before the individual begins to gain weight (COCA)." However, the word "experiment" in this sentence serves as a subject rather than a predicate.

(2) Not being able to get the head and tail of the concordance lines, and hence just copy a whole paragraph or an incomplete sentence from COCA. An example of this kind is: "*result in* reduced performance, increased costs (COCA)."
(3) Not selecting sentences that really make senses to the students themselves. For example, some students quoted such a sentence: "the research team found key distinctions in how these genes *give rise to* PLGGs." However, they were not sure about what a "PLGG" was.

Informed with all the above-mentioned problems, the teacher in the present study gave prompt feedback to students in the second half of the blended learning section—the face-to-face meeting. Remediation measures in the face-to-face meeting were provided as follows:

Firstly, students were given extra instruction on how to figure out the structure of the whole sentence (including subject, predicate and object, etc.). Secondly, they were required to read though the concordance lines carefully and excerpt complete sentences that really make sense to themselves.

Results of the 3rd, 4th and 5th tasks show that almost all students could manage to fulfill the tasks by strictly following the task requirements. And most importantly, they have learned to get the gist of the concordance lines, and interpret correctly the Structure, Meaning and Use (Celce-Murcia and Larsen-Freeman 1999: 5) of the target word(s) (see Fig. 1).


2018临床医学(卓越创新班) 的第1次答题

题目1
完成
满分100.00

Verb Collocates of "innovation" & "breakthrough".

1. innovation
1. encourage(64)---- It should also do more to encourage innovation in and greater access to markets in emerging countries, such as China. (COCA)
2. promote(33)---- The culture must promote continuous innovation -- and foresight skills in recognizing and adapting to change. (COCA)
3. stifle(29)---- These rules must be developed in a way that doesn't stifle innovation and enterprise. (COCA)
4. spur(27)---- Theoretically, it might spur innovation and encourage people to take entrepreneurial risks. (COCA)
5. drive(24)---- Microsystems is committed to investing in the most promising technologies in order to drive our innovation. (COCA)
2.breakthrough
1. was(32)---- That was the breakthrough insight that mammals may be a bit more compatible than we thought. (COCA)
2. had(26)---- They have a goalie, Craig Anderson, who had a breakthrough season as a starter and will be only 29 next month. (COCA)
3. made(7)---- The text says Dr. Damadian made the breakthrough discovery on which all of MRI technology is based. (COCA)
4. developed(5)---- Martin's company, AvidBiotics, has developed a breakthrough protein that can eliminate specific bacteria in the guts of mice. (COCA)
5. won(5)---- Gossip Girl's Ed Westwick won for breakthrough male, while American Idol runner-up Adam Lambert was named artist of the year. (COCA)

Fig. 1. Excerpt of students' performance on the 3rd pre-class task

4.2 Improvement of Collocation Richness in Writing

As is designed in the experiment, the 1st draft writing task (see Task 5 in Appendix A) aims at improving the collocation richness in writing. Records of the sentence-making activities show that students were able to apply the corpus retrieval skills for pattern-hunting while writing the 1st draft of their sentences (see Fig. 2).

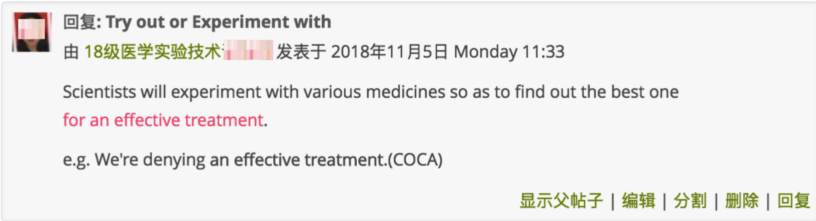


Fig. 2. Screenshot of the 1^{st} draft

As is shown in Fig. 2, this student has used COCA to facilitate her 1^{st} draft writing and wrote: "Scientists will *experiment with* various medicines so as to find out the best one for an effective treatment." This sentence is quite logical and most importantly, it contains a collocation borrowed from COCA—"effective treatment".

Figure 2 serves as an example to suggest that students were enabled to use the phrasal verb "experiment with" correctly as they had searched this phrase in COCA and read through up to five concordance lines of this phrase in the pre-class task. Apart from this, students were empowered to made use of COCA to hunt for patterns like adjective collocates of "treatment" and selected from the frequency list before they decided on "effective treatment", hence enrich the collocation in their 1^{st} drafts.

In short, the pre-class tasks have benefited the students considerably as they have prepared students well for the sentence-making activities in class, in which students can focus on increasing collocation richness of the whole sentence.

4.3 Improvement of Collocation Accuracy in Writing

It is noteworthy that the peer review and 2^{nd} draft writing tasks (see Task 5 in Appendix A) aim at improving collocation accuracy in writing. Records of these two activities indicate that students were able to use corpus effectively for pattern-refining (see Figs. 3 and 4).

Fig. 3. Screenshot of peer review on the 1^{st} draft

Fig. 4. Screenshot of the 2nd draft writing

As is indicated in Fig. 3, one of the students wrote “met many obstacles and setbacks” in the 1st draft. However, the reviewer checked it out in COCA, finding that there were only 8 “meet obstacles” in COCA; furthermore, there was not any “meet setbacks” in COCA. Therefore, she suggested that “met” should be replaced with “faced”, as there are 112 “face obstacles” and 6 “face setbacks” in COCA. She supported her view by quoting two concordance lines (noted with frequency) from COCA. In fact, Fig. 3 is one of the cases showing how students quoted COCA retrieval results as evidence to support their suggestions for improvement in the peer review section.

As is suggested in Fig. 4, one of the students wrote the 1st draft as “I think I should try out something new which I dare not to do before.” However, peer review pointed out that the collocation of “dare not to do” is questionable. Therefore, the original writer searched for the concordance of “dare not” in COCA, and found that “dare not” should be followed with a root form of a verb, rather than an infinitive verb. Consequently, she edited “dare not to do” to be “dare not do” in the 2nd draft, followed with exemplar sentences from COCA. Actually, the case in Fig. 4 serves as an instance to illustrate that these students could use corpus effectively to check out the usage of a target word before making a final decision on the editing work. Consequently, students succeeded in improving the collocation accuracy in their 2nd drafts and ultimately develop themselves to be independent language learners (Kennedy and Miceli 2017).

To sum up, students have gradually shown their improvements in collocation richness and accuracy in the in-class sentence making activities as their corpus retrieval skills getting improved and consolidated in the pre-class tasks.

5 Conclusion and Implications

The present study conducts an experiment on the effectiveness of the blended learning approach to teach EFL students to use corpus to improve the collocation richness and accuracy in their writings. After a qualitative analysis on the students' writing performance, we have generated three findings:

Firstly, students' performance on the pre-class and in-class tasks (the 1st drafts, peer reviews, and the 2nd drafts) show that the blended learning approach is effective in developing students' corpus retrieval skills.

Secondly, records of the five in-class tasks (also called "sentence-making activities") show that the blended learning approach has empowered students to hunt for patterns for the purpose of collocation richness while writing the 1st drafts.

Thirdly, this approach is effective in enabling students to use corpus for the purpose of pattern-refining while providing feedbacks in the peer review activities and the draft editing tasks, hence improve the collocation accuracy in the 2nd drafts.

When it comes to implications for future teaching, for one thing, it is advisable to provide face-to-face training on corpus retrieval skills before the commence of the blended learning sections, which is called "the apprenticeship with corpus use" by Kennedy and Miceli (2010; 2017), so as to avoid the many malpractices occurred in the 1st and 2nd pre-class tasks; for another thing, teachers are suggested to provide more scaffolding support (Rezaee et al. 2015) during the whole teaching experiment, so as to deal with the challenge of facilitating the learning process which is suggested by Boelens et al. (2017).

6 Limitation

It's a great pity that the present study fails to conduct quantitative analysis on students' improvements on collocation richness and accuracy with the help of the blended learning approach. Future research would be suggested to collect both qualitative and quantitative data such as pre-test and post-test scores on students' writing, as well as scores of students' 1st and 2nd drafts.

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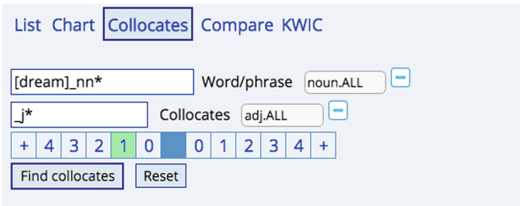
Appendix A: Teaching Procedure for the 4th Blended Learning Section

<table>
<tr><td colspan="2">Corpus retrieval for collocation richness and accuracy</td></tr>
<tr><td>Teaching objects</td><td>First-year undergraduate</td></tr>
<tr><td>Teaching approach</td><td>Blended learning (2 weeks)</td></tr>
<tr><td>Learning tool</td><td>Moodle, COCA, 1Checker</td></tr>
<tr><td>Learning objectives</td><td>Help students to learn:
• The corpus retrieval skills of retrieving Collocates
• to retrieve Collocates in the aim of pattern-hunting while writing the 1st draft
• to retrieve Collocates in the aim of pattern-refining while writing the 2nd draft</td></tr>
<tr><td>Pre-class assignment (Pattern-hunting: remembering, understanding, applying)</td><td>Task 1: Figure out the original and extended meanings of “dream”.
original meaning | a situation or event that you often think about—you would like it to happen.
extended meaning | an imaginary series of events that you experience in your mind while you are asleep.

Task 2: Search for the collocations of “Adj+[dream]” and “V+[dream]” respectively in the free online corpus—COCA.
Directions:
Step 1: Search for the Adj. Collocates of the word “dream” and excerpt concordance lines of the highly-frequent collocates.
Retrieval command:
(1) Use “square bracket” to search for both “dream” and “dreams”, choose “noun.ALL” in the POS (part of speech) query box.
(2) Define the part of speech of the Collocates by choosing adj.ALL in the POS query box.
(3) Define the location of the Collocates to be “Left One” by clicking the number of “1” on the left column.
(4) Click “Find collocates”.

</td></tr>
</table>

	(5) Select 5 of the frequently-collocated Adj.s, quote one concordance line for each of the selected collocate (frequency and reference annotated), and submit. Please write down your findings in this format: adjective + dream/dreams 1. ultimate (52)—"My ultimate dream is to expand All-American Dance Company to 1,000 locations, " she says (COCA). 2. … 3. … Step 2: Search for the V Collocates of the word "dream" and excerpt concordance lines of the highly-frequent collocates. (Detailed steps are the same as Step 1, and are omitted here due to page limitation.) **Task 3**: Complete the sentences with the correct form of the following verbs or adjectives. strange make big accomplish (1) He had finally <u>accomplished</u> his dream of becoming a pilot. (2) You can <u>make</u> that dream come true. (3) Mark said his son had "<u>big</u> dreams" and was hoping to enter international business after college. (4) I woke up this morning from a <u>strange</u> dream—I became superman and was flying in the sky!
In-class assignment (**Pattern-refining**: applying, analyzing, evaluating)	**Task 4**: Function of "V+dream" is _(C)_. (A) Expressing someone's surprise towards fulfilling a dream (B) Giving direction on fulfilling a dream (C) Describing someone's action or result in fulfilling a dream (D) Describing cause and effect of a dream **Task 5**: Please make a sentence with the word "dream", edit your sentence by considering the suggestions by 1Checker, your classmates and teacher. **Directions:** <u>1st draft</u>: Write your sentence with the help of COCA & 1Checker. Quote a concordance line noted with frequency from COCA. <u>Peer review</u>: Review your classmates' sentence(s). You may refer to COCA for help. <u>2nd draft</u>: Edit your sentence with the help of COCA based on your classmates' comments & teacher feedback. Quote a concordance line noted with frequency from COCA.

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Virtual Reality, Augmented Reality and Game-Based Learning

Online Gamified Learning Platforms (OGLPs) for Experiential Learning

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Abstract. Traditional classroom learning approaches make students feel boring and lack of learning motivations in the learning process, especially for some practical courses like tourism and hospitality. Online Gamified Learning Platforms (OGLPs) are useful, but these OGLPs are not as popular as learning tools for students. Therefore, this research aims to identify the factors that influence students' usage intention toward using OGLPs for their learning in tourism and hospitality courses. The research extends the Technology Acceptance Model (TAM) with other factors - 'perceived playfulness', 'knowledge improvement', 'engagement', and 'immersion'. The survey results indicate that knowledge improvement, engagement, and immersion influence perceived usefulness, perceived ease of use, and perceived playfulness; and perceived usefulness, perceived ease of use, and perceived playfulness influence learners' usage intention toward using OGLPs. This study provides a model for studying the gamified learning and recommendations for OGLPs developers to enhance the design of OGLPs.

Keywords: TAM · Perceived playfulness · Gamification · Online gamified platform · Knowledge improvement · Engagement · Immersion

1 Introduction

Nowadays the development of technologies rapidly grows and becomes more popular in our daily lives. Education is one of the areas that obtain benefits by using technologies. The high-speed internet access enables students using different kinds of mobile apps including for educational purposes. Therefore, some educators are investigating ways to motivate students using different types of mobile technologies for supplementing traditional classroom learning.

Among different types of education disciplines, tourism and hospitality education is the one which involves experiential learning approaches that have been found to be valuable methods of bridging the divide between academic knowledge and practical

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skills. However, how to stimulate students' interest and motivate them becomes a problem in tourism and hospitality education. Recently, Maier and Thomas [10] suggested that blended-experiential learning course design and delivery with online learning platforms involved more efficient in the majority of students over traditional classroom design. Filippou, Cheong, and Cheong [7] further suggested the gamified learning approaches for building online learning platforms. They stated that gamified learning can balance learning and fun more effectively than games itself or as entertainment. This type of online learning platform is referred to as Online Gamified Learning Platform (OGLP). OGLP is a new concept for tourism and hospitality education. For developing OGLPs for tourism and hospitality education, the games designed should involve more practical knowledge and real-life business learning. Therefore, there is a need to find out the factors for successfully implementing the OGLPs in tourism and hospitality education.

In previous research, researchers applied the TAM model to test the acceptance of the technology. According to different research settings, some studies added different factors to modify the TAM model. Since this study aims to identify the factors that contribute to students accepting a gamified learning activity in tourism and hospitality education, this study extends TAM model with other variables (perceived playfulness, knowledge improvement, engagement, and immersion) for examining the factors influencing students' usage intention (UI) toward using OGLPs. This study also provides some recommendations for OGLPs developers to enhance the design of OGLPs. It provides a new model for studying the gamified learning and experiential learning approaches.

2 Literature Review

2.1 The Technology Acceptance Model

The Technology Acceptance Model (TAM) is an information system theory that developed for technology acceptance in order to make predictions on technology acceptance. This model suggests that there are a number of factors influence users' decision about how and when they used new technology. TAM is originally based on the causal relationship belief - attitude – intention - behaviour within the theory of reasoned action (TRA).

The development of the TAM by Fred Davis [2] was inspired by the theory of reasoned action (TRA) [6]. In 1985, Fred Davis [2] proposed this model stating that the purpose of the TAM is to explain the determinants of computer acceptance that is generally able to explain the behaviour of users of computing technology [3]. This system can be used to explain or predict the user's motivation which directly influenced by any external factors consisting of the features and capabilities of the actual systems.

Davis [2] defined perceived usefulness as "the degree of belief the use of a certain system would enhance the user's work performance" and the perceived ease of use as "the degree of belief that the use of a system is possible with not much of an effort on the part of the user." Davis [2] claimed that these two factors directly affect users' acceptance of a new technology, whereas attitudes have a direct effect on the willingness and actual use. There were several studies used TAM.

In previous studies, there was research used TAM variables perceived usefulness, perceived ease of use, and additional variable perceived playfulness to test their effects on usage intention of innovative mobile app service [8]. Webster and Martocchio [12] defined micro-computer playfulness as "a situation-specific individual characteristic that represents intellectual or perceived playfulness". In addition, there was recent research tested between the relationship of knowledge, engagement, immersion, enjoyment, and usefulness in gamification learning activity [7]. McMahan [11] defined immersion as "when players are caught up in a game's story or are deeply involved in the strategy of playing the game" and engagement as "Engagement occurs when players derive enjoyment from interacting with the game mechanics". Knowledge improvement was defined as "student perception of whether their knowledge has improved or not when using the gamified tool" [7]. Many researchers interpreted playfulness as an interactive belief for having fun and cognitive immersion [1]. There were less empirical studies on gamification learning activities in tourism and hospitality studies based on TAM; this study tries to extend the studies mentioned above on gamification learning activities in tourism and hospitality studies.

2.2 Gamification and Education in Tourism and Hospitality

Traditional learning in school is assumed to lack of motivation for learning and not effective by students. Although educators try efforts on improving the learning approaches, the main opinion is schools face problem in student's learning motivation and engagement [9]. Deterding et al. [4] defined gamification as the use of game design elements in non-game contexts and growing rapidly in usage in different areas. The use of educational games as learning tools is a promising approach due to their abilities to teach and reinforce not only knowledge but also important skills such as problem-solving, collaboration, and communication and online education sites already used gamification as one of the key elements in learning [5] (Fig. 1).

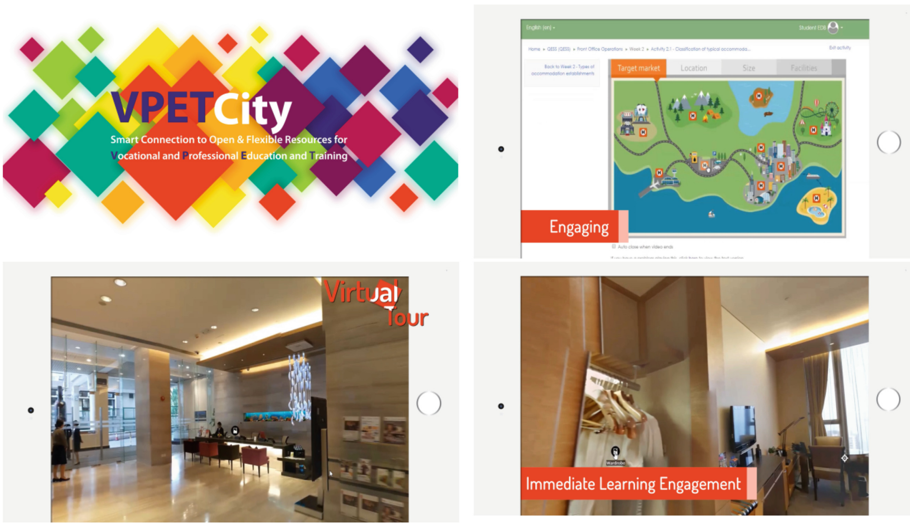

Fig. 1. An example of OGLPs [13]

This research was conducted on one specific online gamified learning platforms (OGLPs), the VPET City (vocational and professional education and training VPET in Hong Kong), where students and teachers can use this platform to perform themes of "instructional differentiation", "innovative pedagogical practices", "flexible learning", and "competency-based and task-oriented instructional strategies" [13]. It includes learning by online gamified methods to stimulate the interest of students to learn in the area of tourism and hospitality. By linking the definitions of interactivity to a gamified learning context, immersion can involve students thinking deeply about how best to use the learning tool at a strategic level. Engagement can involve students making a connection to the game mechanics and enjoying the experience of playing.

3 Research Hypothesis

In this research, a model is developed to measure students' preference for the use of the gamified learning approach and identify factors that influence students' views on this approach. The conceptual model combines two distinct concepts of fun and learning. The constructs of fun include Perceived Playfulness (PP), Perceived Ease of Use (PEOU), Immersion (IM), and Engagement (EG). As part of learning, constructs include Knowledge Improvement (KN) and Perceived Usefulness (PU). The relationships they have between one another culminating in the construction of the conceptual model.

As aforementioned, TAM model that aims to explain user behavioral intentions to use new technology and subsequent usage behavior; Perceived playfulness is proposed to be the third key construct that would contribute any significant impact as similar as the other two constructs (PU and PEOU) as technological acceptance factors influencing university students' Usage Intention (UI) for using OGLPTs for tourism and hospitality learning. Knowledge Improvement, Engagement, and Immersion are proposed as gamification related factors which act as the antecedent factors affecting technological acceptance factors (PU, PEOU, and PP). Fourteen research hypotheses are listed below in as shown in Fig. 2:

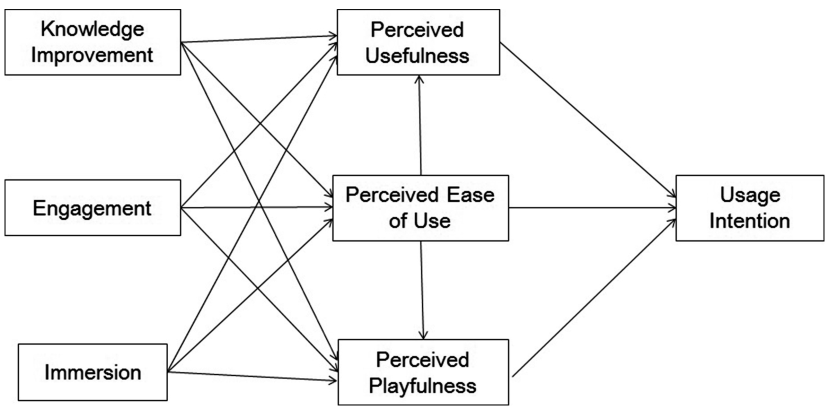

Fig. 2. Research model

H1a: Perceived ease of use of online gamified learning platforms has a positive effect on perceived usefulness.
H1b: Perceived ease of use of online gamified learning platforms has a positive effect on perceived playfulness.
H2a: Perceived ease of use of online gamified learning platforms has a positive effect on usage intention.
H2b: Perceived usefulness of online gamified learning platforms has a positive effect on usage intention.
H2c: Perceived playfulness of online gamified learning platforms has a positive effect on usage intention.
H3a: Knowledge improvement of online gamified learning platforms has a positive effect on perceived ease of use.
H3b: Knowledge improvement of online gamified learning platforms has a positive effect on perceived usefulness.
H3c: Knowledge improvement of online gamified learning platforms has a positive effect on perceived playfulness.
H4a: Engagement of online gamified learning platforms has a positive effect on perceived ease of use.
H4b: Engagement of online gamified learning platforms education has a positive effect on perceived usefulness.
H4c: Engagement of online gamified learning platforms has a positive effect on perceived playfulness.
H5a: Immersion of online gamified learning platforms has a positive effect on perceived ease of use.
H5b: Immersion of online gamified learning platforms has a positive effect on perceived usefulness.
H5c: Immersion of online gamified learning platforms has a positive effect on perceived playfulness.

Pilot test was conducted with twenty qualified respondents. The questionnaire was modified based on the comments of respondents and used in the official research. Finally there were 200 sets of questionnaires collected in September 2018 from the source of tertiary students in Macau. 190 data were valid and analysed via PLS software.

4 Findings

The descriptive information shows that in 190 responses, female are 52% and final year students are 56%. In addition, most of the respondents are at the age of 21 (72%). 7-point Likert-type scale was used in the questionnaire design. The means of PEOU, PU, PP, KN, EG, IM, and IU are scored from 5.13 to 5.86. In addition, within these seven constructs, IM got the lowest scores; examples like on IM-3 “I temporarily forget worries about everyday life while playing the game” and IM-2 “I become unaware of my surroundings while playing the game”. The values of standard deviation and mean for these constructs are shown in Tables 1 and 2.

Table 1. Mean and standard deviation of measurable items

	MEAN	S.D.
PEOU 1	5.616	1.088
PEOU 2	5.647	1.084
PEOU 3	5.616	1.203
PU 1	5.579	1.152
PU 2	5.495	1.104
PU 3	5.384	1.163
PU 4	5.653	1.103
PP 1	5.858	1.074
PP 2	5.716	1.135
PP 3	5.737	1.068
KN 1	5.579	1.101
KN 2	5.226	1.019
KN 3	5.384	1.145
KN 4	5.611	1.039
KN 5	5.674	1.090
EG 1	5.689	1.176
EG 2	5.505	1.239
EG 3	5.337	1.072
EG 4	5.247	1.251
EG 5	5.463	1.208
EG 6	5.126	1.259
IM 1	5.068	1.298
IM 2	4.853	1.289
IM 3	4.768	1.329
IM 4	4.863	1.206
IM 5	5.458	1.108
IM 6	4.879	1.214
UI 1	5.842	1.108
UI 2	5.779	1.102
UI 3	5.763	1.148

Table 2. Average Variance Extracted (AVE), Composite reliability, and Cronbach's alpha

	AVE	Composite reliability	Cronbach's alpha
PEOU	0.822	0.933	0.891
PU	0.801	0.941	0.917
PP	0.896	0.963	0.942
KN	0.67	0.910	0.877
EG	0.643	0.915	0.889
IM	0.691	0.918	0.889
UI	0.889	0.96	0.937

Remark: AVE - average variance extracted,
Italic front – square-root of AVE

Regarding the correlation analysis, refer to Table 3, the correlation values among these seven constructs are significant with all the values less than 0.85. The results of latent variable correlations analysis reflect that the correlations among these seven constructs are reasonable and acceptable.

Table 3. Latent variable correlations analysis

	EG	IM	KN	PEOU	PP	PU	UI
EG	*0.802*						
IM	0.737	*0.831*					
KN	0.785	0.526	*0.819*				
PEOU	0.669	0.426	0.729	*0.907*			
PP	0.743	0.591	0.703	0.678	*0.947*		
PU	0.719	0.540	0.781	0.807	0.752	*0.895*	
UI	0.689	0.494	0.688	0.658	0.678	0.677	*0.943*

Partial Least Squares Structural Equation Modeling (PLS-SEM) was used in this study. 5000 samples in 190 responses have been carried out to assess the significance of the path coefficients among the constructs in the research by using bootstrapping analysis from SmartPLS. Table 4 shows the results of PLS-SEM analysis.

Table 4. Results of PLS-SEM analysis

	Beta value	p-Value	
H1a: Perceived ease of use → Perceived usefulness	0.486	0.000	**Accepted**
H1b: Perceived ease of use → Perceived playfulness	0.279	0.000	**Accepted**
H2a: Perceived ease of use→ Usage intention	0.248	0.008	**Accepted**
H2b: Perceived usefulness → Usage intention	0.216	0.047	**Accepted**
H2c: Perceived playfulness → Usage intention	0.347	0.000	**Accepted**
H3a: Knowledge improvement → Perceived ease of use	0.517	0.000	**Accepted**
H3b: Knowledge improvement → Perceived usefulness	0.323	0.000	**Accepted**
H3c: Knowledge improvement → Perceived playfulness	0.185	0.024	**Accepted**
H4a: Engagement → Perceived ease of use	0.328	0.003	**Accepted**
H4b: Engagement → Perceived usefulness	0.045	0.649	**Rejected**
H4c: Engagement → Perceived playfulness	0.295	0.005	**Accepted**
H5a: Immersion → Perceived ease of use	−0.087	0.301	**Rejected**
H5b: Immersion → Perceived usefulness	0.130	0.049	**Accepted**
H5c: Immersion → Perceived playfulness	0.157	0.024	**Accepted**

According to the above results, Perceived ease of use (PEOU), Perceived usefulness (PU), and Perceived playfulness (PP) have demonstrated the significant influence on university students' Usage intention (UI) toward using OGLPs. H2 is supported. PEOU affects PU and PP, thus, H1 is supported. Knowledge improvement (KN) has demonstrated the most significant influence in PE, PU, and PP. Therefore, H3 is supported; while Engagement (EG) and Immersion (IM) have some hypothesis (H4c and H5a) not being supported (Fig. 3).

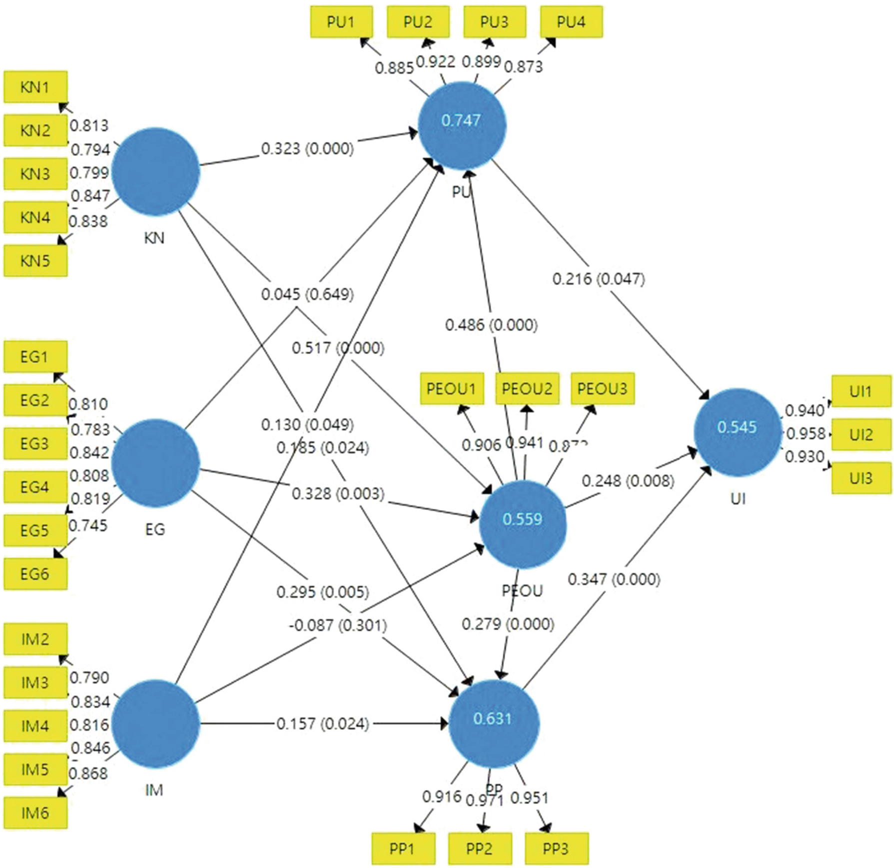

Fig. 3. Results of PLS-SEM analysis

5 Discussion and Conclusion

Internet and IT especially combined with communication are promising tools in the 21 century. For vocational training in universities and institutions, students are required to learn a lot of practical knowledge besides conceptual theories in books and handouts. Thus, skills-oriented knowledge such as hotel check-in service is essential.

The development of online learning platforms provides students with different types of practical knowledge for enhancing their productivities in the real world. However, students may feel boring with traditional online learning platforms, such that this study shows how OGLPs can keep students' continuous learning intention toward the OGLPs. Because OGLPs provide students fun and learning at the same time, this study shows how the crossover of fun and learning factors influencing students' intention toward using OGLPs.

This study achieves its aim and indicates that two constructs (perceived ease of use and perceived usefulness) of TAM model with perceived playfulness of OGLPs are factors that mediate the gamification elements (knowledge improvement, engagement, and immersion) on students' usage intention for OGLPs. This study enhances our knowledge in designing an OGLP, it provides educators a full picture on which gamification related factors they should aware other than technological acceptance factors.

The results of data analysis indicate that most of the research hypotheses are supported. However, some hypotheses are not supported such as immersion does not have a significant influence on perceived ease of use. Researchers can have further qualitative research on these areas.

This study only tests the factors with university students. However, staff in different hospitality and tourism sectors is also required to have on-job skill-oriented training. For employees, the OGLPs provide them a flexible training environment which raises their interest to learn hence the motivation to work. For employers, the OGLPs provide them a low-cost ad-hoc training tool for their new staff. It is important that organisations train their casual staff by increasing practical knowledge with a more creative, interesting, and flexible learning style. Therefore, researchers can extend this research model to test their behavioural intention toward OGLPs.

Last but not least researchers would recommend border research on other online learning platforms except in tourism and hospitality, and it will contribute in the areas of online learning platform design for online learning platform developers.

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Primary School Students' Science Inquiry Learning and Behavior Patterns While Exploring Augmented Reality Science Learning

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Abstract. Scientific inquiry has been recognized as an effective instructions ability for learners in science education. The present study aims to explore the behavioral patterns of the science inquiry learning process and the behavior patterns of conception construction in augmented reality (AR) science learning activities for primary school students. An AR-based inquiry learning activity of "Exploring the External Conditions of Seed Germination" was supported, which is an attempt to integrate virtual objects with real situations. Learners utilize the AR based learning materials to accumulate experiences and identify problems while observing and perceiving science concepts. They carry out scientific inquiry based on problems. The scientific inquiry learning can be implemented the following eight-step teaching strategies: constructing environment with AR, revealing misconception under experience, correcting mistakes through AR concepts, obtaining new knowledge by reflection and exploration, establishing the experimental scheme with AR, bringing the scheme to completion by modifying, solving scientific questions through AR, making progress under self-reflection. Students' learning behaviors were analyzed by adopting behavioral sequence analysis. The results suggest that the eight-step teaching strategies may support learners' inquiry learning processes to achieve a positive outcome for their self-efficacy in science inquiry learning.

Keywords: Augmented reality · Sequential analysis · Science education · Scientific inquiry · Behavioral pattern · Self-efficacy

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1 Introduction

Some conception in science education is nonobjective and microscopic views, which make students result in misconceptions in the process of science learning. AR technology presents students with a microscopic scientific environment and a virtual model. Students in the classroom transform nonobjective concepts into elements of real images and 3D models to enhance their conceptual learning and spatial cognition. It has been reported in the literature that there is growing demand for making use of AR to solve the problem of misconceptions in science education. According to Linder, Rienow and Jürgens's study of the designed App "The Earth-Moon System" [1], an empirical study was conducted by AR, which involved the effects of changing in the distance between Earth and Moon as well as a 3D animation between two celestial bodies. The results revealed that it was usable to apply AR to help understanding complex topics. Mustafa and Cakmak [2] implemented an AR application called AtomAR in astronomy, which was one of the difficult science subjects for students to learn at a concepts level. Their study certificated that AR made positive contributions to the misconceptions of students, without affecting their course engagement. These studies enlighten our study to pay more attention to the complex science subjects which impossible for most learners to learn by observing or making an intervention. In order to ensure that students can deeply understand as well as apply the concepts and knowledge to practice, the teaching process is required a combination of various forms of teaching, such as theory, practice and discussion. Another study proposed to combine field experience and the use of information technology to create a problem-based learning environment (Simmons, Wu, Knight and Lopez) [3]. According to this literature, our study found that learners can participate in real scientific inquiry in such an environment supported by AR.

2 Literature Review

2.1 Research on the Practice of Science Inquiry Learning Supported by AR

Science inquiry learning supported by AR is defined as an instruction to use AR for solving difficult teaching problems, such as explaining nonobjective knowledge, observing the micro world, conducting experiments in a virtual simulation environment, etc. Behmke's study [4] adopted the AR molecule applications at the end of a conventional three-dimensional chemistry teaching. He indicated that AR technology greatly enhanced the experimental group students' enthusiasm to assist them more clearly to describe the three-dimensional structure of the molecule. Duan, Ni, Wu, Fang and Zhang [5] designed AR physics experiment autonomous environment when students learned physics experiment instruments. A majority of students who used the instrument were satisfied with the learning outcomes. Chiang, Yang and Hwang [6] allowed students to use AR scanning for inquiry-based learning while studying aquatic plants. The students were divided into the experimental group and the control group, while the former one held a higher level of knowledge construction. Wu, Hwang, Yang and Chen [7] used AR learning system which based on a database to facilitate students' construction to enable students to learn insect knowledge. As a result, students' knowledge construction and academic performance will be better than with traditional AR learning systems. Cai, Wang and Chiang [8] implemented AR simulation system in a chemistry class, and concluded that the AR inquiry-based learning tool prominently contributed to learning effects. In brief, it has been proved that AR plays a crucial role in science inquiry learning.

2.2 Research on Science Inquiry Learning Supported by AR Based on Behavior Analysis

In recent years, the use of emerging information technology to conduct experiential learning research has received widespread attention. However, there is still a lack in quantifying the teaching process and evaluating students' learning outcomes. Secondly, it is difficult for educators to define, implement and evaluate student-centered instruction. Analyzing their behavior helps researchers and educators understand two key points. One is the methodology that promote students to master knowledge, another one is the analysis of the ability cultivation from the overall level. The method of behavior analysis might contribute to improve classroom teaching outcome. The general steps for this method are summarized as follow. Firstly, according to the activity process of teaching and learning, the behavior of teachers and students is divided into certain categories. Subsequently, based on classroom teaching video, conversion sampling is carried out to form behavioral data sequence. For example, Chiang, et al. [6] analyzed the various behaviors when students used AR scanning aquatic plants to learn related knowledge. Furthermore, the results showed the degree of knowledge construction and learning concentration. With the help of a series of analyses of behavioral patterns and cognitive attainment, Cheng and Tsai [9] explored how children and parents read the AR book. Moreover, they examined the children's and parents' reading behavioral patterns while they participated in the process of reading the AR book through cluster analysis. Besides, Cheng, et al. [9] proposed that it is benefit for promoting children and parents' communication and transfer of the AR book reading by integrating a prompting guidance in an AR book system.

The purpose of this study is proposed to answer the following research questions:

(1) How many kinds of learning behaviors do students have in AR-based inquiry learning in science courses?
(2) Are there different sequential patterns of interaction for different kinds of learning behaviors while exploring AR-based inquiry augmented reality science learning?

3 Design and Methods

3.1 Participants and Procedures

Eight fourth-grade or fifth-grade students (2 male; 6 female) with an average age of 11 years were recruited from Guangdong, Southern China. They were invited randomly to take part in this study. According to a short interview before the study, all of them had experience of using smart phones but less of using AR.

This study mainly validated the feasibility of the strategy through classroom experiments and optimized eight-step teaching strategy based on AR. The study lasted for a period of 8 weeks, involving two 45-m lessons per week. Participants were randomly divided into two groups for collaborative learning. During the class, we use two cameras to record students' learning behavior.

In this case study, each lesson was divided into seven stages: the pre-class introduction stage (CU) - the AR observing stage (CU, PW) - the teacher explaining stage (HCS, CU) - the new knowledge consolidating stage (HCS, PW) – the experimental designing with AR stage (PW, HCS, SC) – the experimental verification with AR stage (PW, HCS, SC) - the knowledge summary stage (EA). The content of the lecture was based on the AR materials, from the growth of seeds to the internal structure of plant cells.

3.2 The AR-Based Learning System

In the article "the scientific education application of AR experiential teaching resources: strategies and cases", Lin, Zhu, Wu, Shen and Wang (2019) [10] mentioned the eight-step innovative teaching strategy of AR supported experiential learning, which is constructing environment with AR, revealing misconception under experience, correcting mistakes through AR concepts, obtaining new knowledge by reflection and exploration, establishing the experimental scheme with AR, bringing the scheme to completion by modifying, solving scientific questions through AR, making progress under self-reflection. Under the guidance of the eight-step innovative teaching strategy, this study took "exploring the external conditions of seed germination" as a case to implement the teaching design. In this way, five aspects in science learning was implemented based on the eight-step innovative teaching strategy of AR: Conceptual Understanding (CU), Practical Work (PW), Higher-Order Cognitive Skills (HCS), Science Communication (SC) and Everyday Application (EA). For example, during the process of establishing the experimental scheme with AR to bring the scheme to completion by modifying. Students worked in groups to explore the process of photosynthesis. Students experienced a series of learning activities, for example, they wrote experiment plans, made mutual evaluation and applied AR equipment to carry out experiment plans. At that time, Students' self-efficacy was improved in the following aspects, namely, Practical Work (PW), Higher-Order Cognitive Skills (HCS) and Scientific Communication (SC). Based on the guidance of questions, learners firstly mastered the writing steps of the experimental scheme from "the willow experiment of Helmont". At the same time, questions were raised about the conclusion of the experiment – it was proposed that the weight gain of willow trees may also come from other materials, such as the process of photosynthesis, the generation of oxygen and organic matter by carbon dioxide and water under certain conditions of light, etc., and a point of which was questioned was studied in the group experiment design. For example, to explore whether photosynthesis produces organic or not, the team worked together to design the geranium experiment with the help of the teacher. First of all, the principle was defined. Organic starch was produced by photosynthesis. Starch solution reacted with iodine solution to turn blue. Then, photosynthetic products from the geranium were obtained and tested for starch according to the principle. At this time, two problems were easily ignored in experimental design: one was the photosynthetic products which produced by plants before experiments must be completely consumed, the other was the pigment of the leaves had an effect on the observation. As for these two problems, teachers who acted as facilitators would provide material to assist students in designing the experiment. Students will be instructed to leave the plants in the dark for 24 h and soak the leaves in a water bath heated with alcohol to remove pigment. After the experimental scheme of the group is defined, different modes were selected to implement the experimental scheme by using AR resources for experimental verification, and the key points and difficulties in the experimental process were consolidated and summarized by making use of matters needing attention to compete with each other in games.

Throughout the whole process, students corrected the misconceptions of the seed germination need lighting, and correctly differentiated the seed germination and plant growth. Through the participation of learners in each teaching stage, this study documented all of the valid behaviors that students had performed in the five aspects of science learning (CU, PW, HCS, SC, EA) and encoded them. After that, through behavioral clustering of coding behaviors, we summarized the different behaviors what students would perform at each stage of scientific learning, and then improved the eight-step teaching strategy (Fig. 1).

3.3 The AR-Based Learning Material

AR material was implemented in the whole teaching process, including learning observation, experimental verification, experience comparison and so on. In this study, AR resources based on pattern markers are adopted to form the learning manual as shown in Fig. 2 below. In the study of "exploring the external conditions of seed germination", learners can obtain the corresponding AR material on the mobile terminal by scanning the AR logo on the manual. The learning framework, such as the mode, time and guidance of each teaching activity, is clearly presented in the study manual, which can be used as auxiliary teaching materials for classroom teaching. Learners can also scan the QR code of the expanded reading module after class to obtain online learning resources for expanding reading, reviewing and consolidating the knowledge.

3.4 Data Collection and Analysis

The data analysis consisted of two steps: cluster analysis to analyze the students' behavioral clustering in each stage and Lag Sequence Analysis (LSA) to organize the conversion relationship between various behavior sets from the previous analysis. The behavioral coding schemes of this study was used to collect students' behavioral data in class for cluster analysis and difference comparison. In terms of content, we combed out the students' behaviors which were observed in the process of teaching practice by combining our own teaching design and the extended eight-step teaching method. In terms of the framework, we adapted the behavior coding schemes from Liu's [11]

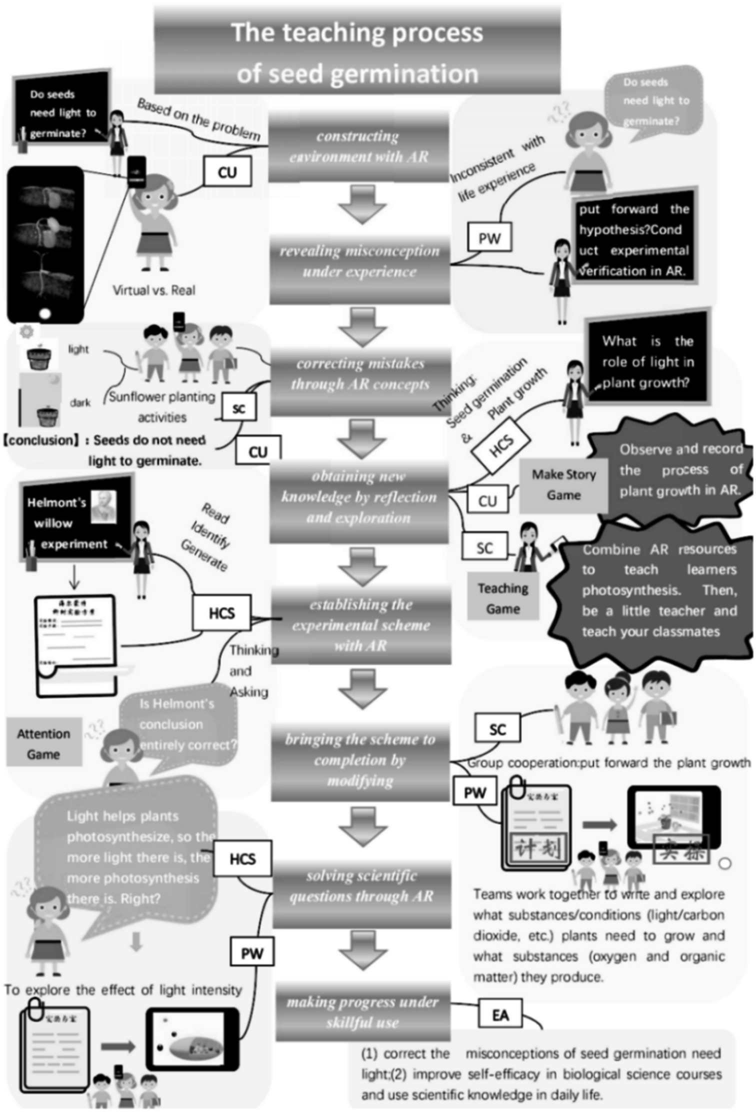

Fig. 1. A flowchart of experimental teaching activities of seed germination. Note: Conceptual Understanding (CU), Practical Work (PW), Higher-Order Cognitive Skills (HCS), Science Communication (SC) and Everyday Application (EA).

analysis coding of classroom interaction behavior. The original coding method belonged to the field of educational information technology. It was applied to encode the interaction between teachers and students based on learning activities, which had been recorded into the video. In this study, the coding method was refined and modified into a new coding form. As shown in Table 1, the codes were divided into 12 measurement dimensions, and 14 items were specifically recorded.

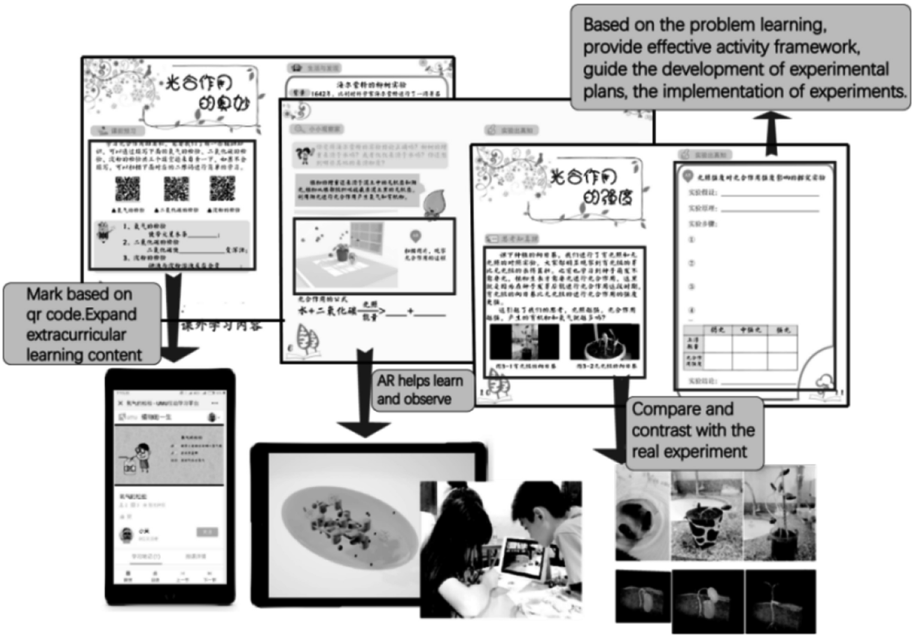

Fig. 2. A learning manual of using mark-based AR in learning activities

Table 1. The coding schemes for science inquiry learning behaviors.

Interaction		Behavior		Code
The interaction between students and teachers	Students' initiative behavior	Put question		1
		Reading and recording		2
	Students' passive behavior	Observing		3
		Answering		4
		Practicing		5
		Showing		6
The interaction between students		Discussing		7
		Cooperating (Using AR resources together with peers)		8
		Experiment	Assuming	9
			Exploring	10
			verifying	11
Student alone		Operating (Using AR resources along)		12
		Thinking		13
		Distracting		14

On basis of the coding form, a code was recorded for each change in the student's behaviors and finally a total of 3204 codes was coded. In the end of cluster analysis, five classifications were sorted out from the codes of students' behavior. For describing the clustering results, a framework consisting of five activities to classify students' understanding of scientific concepts proposed by Zhang and Scardamalia [12] was adapted as another new coding scheme: (1) Non-scientific; (2) Pre-scientific; (3) Hybrid/Mixed; (4) Basically scientific; (5) Scientific. The codes used, the description of codes, and the corresponding students' behaviors are presented in Table 2.

Table 2. The coding schemes for AR assisted science-related conceptual development behaviors.

Codes	Description	Behaviors
Non-scientific (N)	Student does not address the question, instead expressing emotion or chatting to other students	Distracting, chatting to other students
Pre-scientific (P)	Student responds to the question naively or based on personal experience	Answering, thinking
Hybrid/Mixed (H)	Student responds to the question with others help	Practicing, cooperating, assuming
Basically scientific (B)	Student responds to the questions using scientific knowledge but without examples or explanation	Reading and recording, presentation, observing
Scientific (S)	The student draws on Previous discussion and scientific concepts to suggest an explanation or hypothesis that may help resolve the question or problem under consideration in experiment with teachers' help	Exploring, verifying, asking question, practicing, discussing

Then, the researchers took secondary coding of student behavior according to the new coding table. And 763 code strings which were coded based on their chronological order were analyzed to calculate the frequency of each behavioral code following another one. Finally, the analysis tool PuliPuli was used to process the code-strings data for LSA.

4 Results

This study focus on analyzing the learning behavior of students in the AR-based experiential science classroom scenario. In the process of scientific inquiry, students often have two or more behaviors that appear repeatedly. For example, in the conceptual understanding of "exploring the external conditions of seed germination", students are often accompanied by several behaviors such as "observing", "reading" and "recording". Therefore, in the experiment, we collected and organized the students' behaviors, trying to help us modify and perfect the eight-step teaching strategy by analyzing the students' behavioral clustering.

As is described in Table 2, five clusters were identified. Behaviors in cluster 1 were distraction. Cluster 2 consisted of answering and thinking. Cluster 3 were practice, cooperation and assuming. Cluster 4 consisted of reading, display and observation. And Cluster 5 were inquiry, verification, questioning, operation and discussion.

With the help of this classification, we re-encoded the process of our teaching, following the principle of recording once the action changes, and setting the five codes to N, P, H, B, and S, corresponding to the five stages in Table 2. In order to investigate the behavioral patterns of AR-based science inquiry learning in depth so as to answer the second research question, a series of LSA were conducted. The results indicates that six sequences reached statistically significant difference ($p < 0.05$). As is illustrated in Fig. 3, six significant sequences were emerged in students' AR Science Inquiry Learning: N → B, B → N, B → P, P → B, H → S, S → B. In the diagrams, the arrow indicates the direction of the behavior transfer for each sequence, while the thickness of the arrow represents the strength of transition probability and the values above the arrow shows Z-value of each sequence.

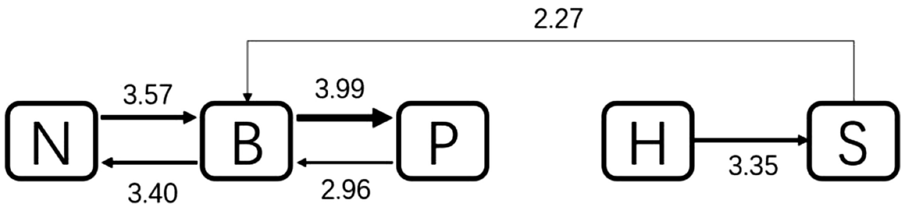

Fig. 3. Sequential behavioral patterns of students' AR Science Inquiry Learning.

5 Discussion

The first purpose of this study was to investigate the framework of students' learning behaviors in AR-based science inquiry learning. The results indicated that under the AR-supported experiential teaching strategy, the behaviors of the students in the seven stages of instructional design are not significantly different, which indicated that the seven different stages of teaching had similar effects on students' learning behaviors. During the teaching process, the students' "observation" behaviors predominated over other behaviors, while the frequency of "exploration" and "validation" behaviors were relatively low, occurring only once in every two lessons. There were two reasons for observation becoming the most frequent behaviors. For one reason, Chiang and Hwang's research adopted that [13] the AR-based flipped learning guiding approach can play a beneficial role in the students' promotion of their project performance. Moreover, students' learning motivation, critical thinking tendency and group self-efficacy could be improved in the process. Therefore, in the instructional design, was students were requited to discover different phenomena in AR resources and common sense of life through "observation" as well as to ask questions in their earlier stage of learning. For another reason, when the students used AR resources to practice and scientific inquiry, they "observed" the phenomenon, found mistakes and corrected mistakes. At the same time, the reasons for the less occurrence of "exploration" and "validation" due to the fact that the courses on these behaviors were concentrated in the last four lessons, and each inquiry was scheduled for at most one inquiry experiment. Besides, the scientific inquiry activity is a process of continuity and the need for more behaviors such as observation, thinking, hypothesis and operation. As a result, the students' "exploration" and "validation" behaviors only occurred once or twice conforming to the predictions of experimental studies. In addition, the "distraction" behavior occurred frequently. By reviewing the classroom observations and records, the main reason for the students' distraction was that students pay too much attention to the AR resources and neglect the teacher's teaching. In the process of cooperation, some students were not actively involved in the cooperation, instead of waiting for the team members to get the answer.

Further through cluster analysis, this study found that the clustering results of students' learning behaviors are basically consistent with the prediction results of the experiential teaching strategies supported by AR (>50%). The five behaviors of inquiry, verification, questioning, operation and discussion of students are concentrated, which shows that it is correct and effective to use AR resources and teacher guidance to assist students in group cooperation in instructional design. The two categories of "answer and think", "practice, cooperation and hypothesis" can also correspond to the two steps of "AR creation scenario and problem discovery" and "use AR design experiment phase" in the teaching phase. For the categories of "reading, showing and observing", it can be attributed to the fact that when the students are grouped, when the experimental results are displayed, the behaviors of comparing the results and answers between the groups frequently appear. From these results, the proposed AR eight-step teaching strategies do have a positive correlation with students' science learning.

In order to answer the second research question, the students' behavioral patterns of AR-based science inquiry learning were revealed through lag sequence analysis. By using LSA, there were five important behavioral patterns in the whole teaching process. As was recommended by Lin, Duh, Li, H. Wang and Tsai [14], the AR system can be used as a supporting tool to enable dual learners to respond quickly to the displayed results and promote their knowledge building process to produce favorable learning effects. Therefore, we believe that the change of $H \rightarrow S$ ($Z = 3.35$) belongs to the natural phenomenon after the construction of students' knowledge, which shows that AR technology can indeed provide greater help in improving students' ability to learn scientific knowledge. The transformation of $P \rightarrow B$, $S \rightarrow B$ ($Z = 2.96, 2.27$) is mainly related to instructional design. $P \rightarrow B$ corresponds to the first four steps of AR teaching design focusing on students' independent knowledge learning, and $S \rightarrow B$ corresponds to the last four steps of constructive improvement.

In summary, when conducting science teaching using AR technology, special attention should be paid to the transition between knowledge points and how to prevent students' attention from being over-dispersed by the new element of AR technology. The influence of AR technology on science teaching is mainly concentrated in the stage of pre-school preparation and preliminary study, which makes it is necessary to pay attention to the teaching design. This study examined that the design of the teaching link for experimental inquiry could be improved. Students should be guided to conduct of pre-school preparation and preliminary study, which makes it is necessary to pay attention to the teaching design. This effectively improve students' collaborative inquiry ability.

6 Conclusion

In this study, a teaching approach supported by AR eight-step teaching strategies was conducted to improve the teaching design of scientific inquiry learning of misconceptions of "necessity and sufficiency of seed generation". In these cases, behavioral analysis can clearly highlight students' behavioral characteristics. Therefore, this study mainly collects students' behavior from three aspects: the interaction between students, the interaction between students and teachers and student personal behaviors. The classroom teaching is carried out under the policy to support innovative teaching in the thirteen specific AR-based step behaviors, including questioning, observing, answering, practicing, displaying, discussing, collaborating, doing experiment assumptions, exploring, verifying operation learn resources and thinking. To sum up, two major contributions and suggestions of this study are proposed for further study: (1) in the student-centered AR experiential teaching process, the role of teachers' instructor and assistant should be noted. Instead of divorcing from the classroom, teachers should give clear guidance on students' learning behavior to ensure that students understand how to conduct autonomous and cooperative learning; (2) AR teaching material should be designed to make use of the advantages of AR. Clearing learning guidance in resources can make learners to result in better learning achievements with less effort. Students can get the answers by their own efforts in the process of completing the learning tasks.

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The Exploration on Interacting Teaching Mode of Augmented Reality Based on HoloLens

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Abstract. In recent years, the applications of augmented reality and the visualization of mixed reality for education are popular. However the lacking of multi-modal interaction for teaching and learning results in the teaching mode staying at the teacher-centered knowledge-feeding pattern, and the ability of the AR technology underutilized. This paper proposes an interactive teaching mode of augmented reality based on HoloLens, taking full advantage of the device which combines 3D scenes, audio, video and teaching content. Applying gesture, voice, holographic interaction and viewpoint tracking technology to practical teaching, this paper demonstrates a new student-centered teaching mode which includes the dynamic classroom teaching, multi-modal interactive practicing and the multi-form feedback learning. This paper carries out an empirical research in senior one students. The results indicate that the interest and initiative of students in learning are increased, the ability of understanding abstract knowledge is significantly improved, and the academic performance of students is promoted. This paper is devoted to promoting the deep integration of augmented reality and teaching, the innovation in teaching process and method has been explored positively.

Keywords: Augmented reality HoloLens · Interactive learning · Learning environment · Nonlinear interactive teaching mode · Mobile learning

1 Introduction

Augmented Reality technology has developed rapidly and has become an important technology to improve people's quality of life. On the purpose of supplementing the real environment, Augmented Reality technology superimposes the virtual information generated by the computer into the real environment, based on computer display, interaction, network tracking and positioning technology. The cheaper equipment and the easier applications make Augmented Reality popular in games, industry, education and other fields.

There are a lot of applications and teaching experience of Augmented Reality technology in education domestic and international. The integration of virtual and real

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interactive mode in education is reforming the traditional teaching mode, which has significant effects on changing the relationships among the learning content, learning style and learning environment. The traditional teaching mode, the teacher-centered classroom teaching style only use the Augmented Reality in simply displaying. Thus the teaching process is one-way and linear, the learners do not explore the learning materials via the latest technology.

1.1 The Background of Augmented Reality Technology Used in Education

The earliest application of Augmented Reality technology in education was the Magic Book proposed by Billinghurst [1]. They used Augmented Reality technology to create corresponding 3D models based on the contents of the book. Children could observe the model by wearing special glasses to implement the effect of combining reality world with abstract knowledge. However, you could only observe the model and you couldn't interact with the model by hand.

Researchers at the Vienna University of Technology conducted a study of AR technology application in mechanics teaching. The physics engine was used to simulate the physical experiments of experimental mechanics. Students could not only observe models, but also use gestures to interact with the models [2].

Chang (2013) designed an experiment to study the learning behavior of students under the nuclear radiation pollution environment near the Fukushima Daiichi nuclear power plant [3]. These activities could make students feel the impact of radiation pollution. These studies demonstrated the prospects of Augmented Reality technology for emergency response education. It could effectively influence learners' attitude towards emergencies.

In China, many researchers have actively explored and demonstrated the use of AR in Education.

1. Chemistry

Su Cai (2014) and other teachers of Beijing Normal University designed a number of experiments on the virtual and real fusion of chemical materials in junior high schools [4]. The way of interaction can greatly enhance students' interest in learning and strengthen their understanding of the physical microstructure.

2. English

He, Ren and etc. (2014) designed the application named "Happy Words" on mobile device which could scan the word through the camera on the phone or tablet PC [5]. In this way, children could quickly enhance their interest in learning.

3. Special education

Zhu designed (2015) a series of gesture-based matching games by combining the gesture recognition device named Leap Motion with AR technology. It could help children with autism improve their spatial perception and practical ability [6].

The above cases show that AR technology can create a real scientific learning environment, allowing learners to have more initiative. HoloLens can be an interesting and practical learning aid for students, which strengthens students' various disciplines and promotes students' deep understanding. However, it can be seen from the above that the application of Augmented Reality technology in teaching is relatively monotonous, the teaching resources are not fully utilized. The application of Augmented Reality technology in teaching is still in its infancy.

1.2 Augmented Reality Technology Applied to the Education

Augmented Reality technology makes abstract learning more concrete. It enhances the intuition and concentration of learners. Educators are tireless in their pursuit of Augmented Reality technology in education.

With the development of many wireless devices and local registration technologies, ubiquitous collaborative learning and situational learning can be enhanced. The teaching mode obtained by the whole system has the advantages of strong interaction, high convenience, and outstanding personalization.

AR technology is used to construct a scenes such as a science museum. Compared with the traditional teaching mode, the interactive teaching model based on augmented reality technology has two innovations: various teaching modes and teaching contents can be used; interactive teaching organization promotes communication between students and teachers.

2 Interactive Teaching Mode Based on Augmented Reality Technology

2.1 Comparison Between Traditional Teaching Mode and Interactive Teaching Mode Based on Augmented Reality Technology

The traditional teaching mode mainly includes the transfer and the internalization of knowledge. In the traditional teaching mode, teachers are the main guides. While in the process of knowledge internalization, the students need to take a lot of practice. In the interactive teaching mode based on HoloLens, the knowledge internalization is completed with the auxiliary of Augmented Reality technology. The comparison of the various elements between traditional teaching mode and interactive teaching mode is shown in Table 1.

Table 1. Comparison of elements between traditional teaching mode and nonlinear active interactive teaching mode

	Traditional teaching mode	Interactive teaching mode
Teacher	Classroom manager	Classroom assistant
Student	Passive receiver	Active learner
Teaching form	Teaching After-school training	Teaching After-school feedback Interactive learning
Classroom content	Knowledge explanation	Problem exploration
Technical application	Display	Enhanced display Autonomous interaction exploration Collaborative discussion

2.2 The Embodiment of Interactive Teaching Mode Based on Augmented Reality Technology in High School Geography Teaching

In the traditional geography teaching mode, teachers pay more attention to students' academic performance and less attention to students' psychological state in the learning activities. Under this circumstance, the knowledge cannot be applied in practice, which is not in line with the teaching objectives of cultivating students' geographical thinking and improving geographical teaching quality. The interactive teaching mode based on Augmented Reality technology enhances students' ability to use geography knowledge in the following ways:

- Augmented Reality technology and geographical knowledge have been fully integrated, which lets students take the initiative to participate.

Because of the particularity of geography teaching, a large number of maps and models have appeared in geography teaching. When students interact with 3D models. They obtain a lot of useful geographic information by exploring independently. For example, in the chapter of celestial bodies in high school geography, students use the voice and gestures to zoom in, zoom out and move the 3D models of celestial bodies. They understand the intrinsic connection between celestial bodies by video. They can understand the particularity and universality of the earth with the help of HoloLens. They can acquire more knowledge through independent exploration and master the appropriate learning methods by using Augmented Reality technology. As shown in Fig. 1.

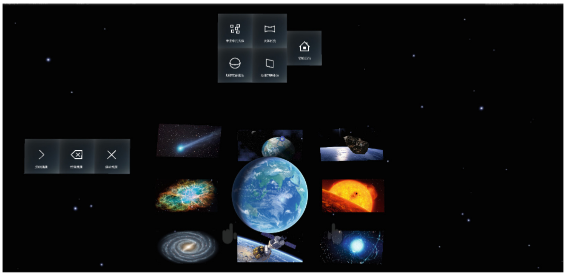


Fig. 1. Interactive celestial scene

There is more cooperation between students. There is less interaction between students in the traditional teaching mode. Individuals are independent learners. A multi-person collaborative demonstration is proposed in the interactive teaching mode of AR. At the same time, different students are equipped with different devices to interact with the same Augmented Reality scene. Taking high school geography teaching as an example, when students have doubts about the particularity of the earth, other students in the same group can demonstrate the formation of atmosphere to him (Fig. 2).

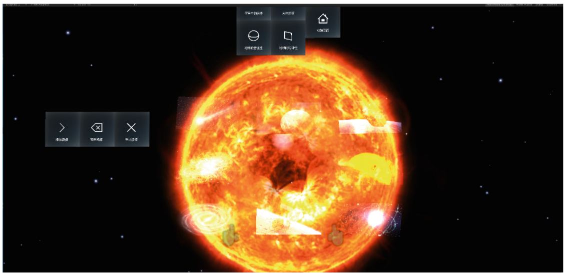


Fig. 2. Picture of the star

- More communication between students and teachers.

In the new teaching mode, the teaching environment is relatively relaxed and pleasant. The teacher conducts demonstrations while teaching. As for the abstract knowledge that is difficult to understand, the students can use the equipment to deepen understanding. The cooperation has been formed between students and teachers. For example, in the geography classroom, the teacher's teaching and presentation are synchronized. In the process of the exploration, the problem is directly fed back to the teachers.

3 Classroom Teaching

3.1 Interactive Teaching Mode

The interactive teaching mode of Augmented Reality based on HoloLens realizes the relationship between knowledge imparting and knowledge internalization. The knowledge in the traditional classroom is acquired in interactive learning. According to the connotation of interactive teaching mode and instructional design theory, the teaching mode is mainly composed of three parts. In the three parts, augmented reality technology and mobile learning are powerful tools for the construction and generation of interactive learning environment. As shown in Fig. 3.

3.2 Creating Interactive Teaching Resources of Augmented Reality Based on HoloLens

Considering the appropriate interactions and models, we collect resources, and construct links between knowledge and models for different disciplines. The teaching characteristics of different disciplines are various. For example, in the geography class, the understanding and mastery of the geographical concept are emphasized. Models

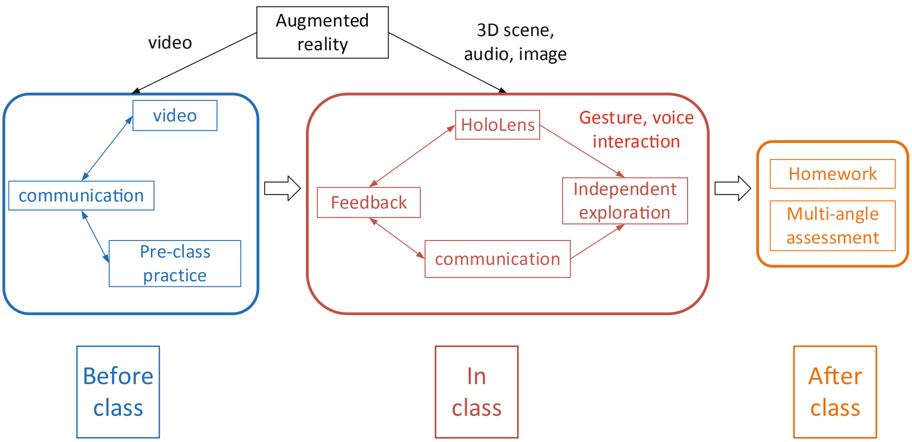


Fig. 3. Augmented reality interactive teaching mode based on HoloLens

such as the Earth, the Moon and the Sun are produced according to the true state. After importing models into the Unity, the scene is configured and developed, so that the wearer can observe the revolution system of the Earth around the Sun while using the teaching application. The experiencer can click the virtual button in the interface to move, rotate, zoom in or zoom out the models. This interaction can also be applied to other celestial models.

3.3 Augmented Reality Interactive Teaching Method Based on HoloLens

The HoloLens constructs local area networks. It shares virtual objects and space anchors between multiple devices. When teachers operate virtual objects, students can observe synchronously through the device. Taking high school geography teaching as an example, teachers wear equipments to demonstrate the rotation of the earth for students on the same local area network. The earth model can also be scaled to focus on some key knowledge, such as the regression line.

3.4 Augmented Reality Teaching Interaction Based on HoloLens

- Using Video Screens for Pre-class Demonstrations

The multimedia teaching video embedded in the augmented reality teaching software based on HoloLens. The first lecture named “Cosmos, Celestial Body, Celestial System” and the second lecture named “Earth - ordinary and special planet” on the topic of “Earth in the Universe” comes from the online quality course. The user can use AirTap gesture to click the UI video play button, or use the voice “play” to play the videos. When the video is playing, the user can also use the AirTap gesture to pause the video, or use both hands to rotate, zoom in and zoom out the video.

- Explaining the Celestial Movement Chapter Using Gesture Control Interaction

AirTap gesture: A gesture specified by the HoloLens, which can be used to click the interactive buttons on the interface. As shown in Fig. 4.

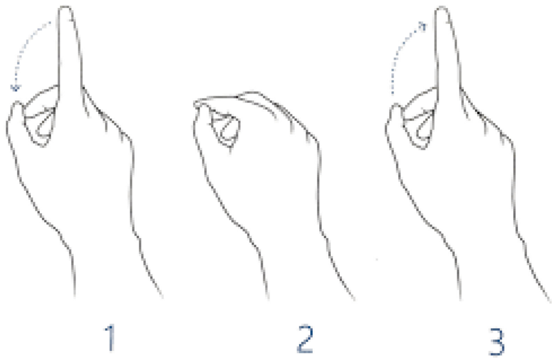


Fig. 4. AirTap Gesture

Two-hand gesture: A gesture that uses AirTap gesture to work together with both hands (both hands must be detected by HoloLens at the same time). The model can be zoomed in and out when both hands are simultaneously active.

Drag and drop: Move the hand while keeping the AirTap gesture.

The holographic buttons are used in the UI interface designed for the geography teaching system. The users can click on the button with the AirTap gesture. The main function of UI interface is to switch the learning scenes and play back the multimedia teaching videos. As shown in Fig. 5.

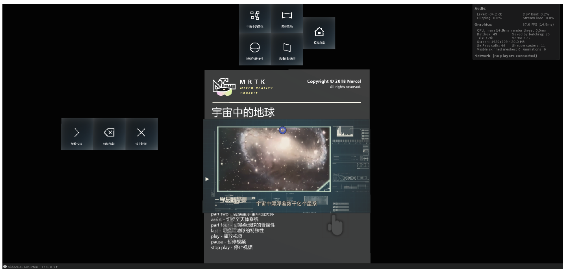


Fig. 5. UI interface in the upper left field of view

For example, in a celestial scene, users can see pictures of eight different celestial bodies. When the users gaze at the corresponding picture, the name of the celestial body is displayed next to the picture. When the users click the corresponding picture with the Airtap gesture, the holographic model or particle effect of the celestial body is displayed. Learners can vividly and intuitively observe the characteristics of different celestial bodies. As shown in Figs. 6 and 7.

Fig. 6. Celestial scene

Fig. 7. Celestial scene (crab nebula particle)

- Selecting Speech Recognition Interaction for Cosmic Scene Switching

In the main scene (initial page), the user can see a virtual description window suspended in midair. The description window will explain the learning objectives of the course, the development tools of the project, and the keywords of the voice interaction. The left side of the signboard is virtual buttons for controlling multimedia teaching videos. The multimedia teaching videos can be played, paused and stopped by voice. The video management signboard is provided in each scene. Users can also realize the function of the virtual button through specified voice instruction. As shown in Fig. 8.

Fig. 8. Initial page

4 Experiment

This paper makes an empirical study of HoloLens-based learning environment in the field of geography, taking the first section of the earth in the universe in high school geography as an example, which is divided into three major parts: celestial bodies, celestial systems and the universality and particularity of the earth. It is hoped that the advantages of Augmented Reality technology in education will be discussed with the researchers of educational technology through the introduction of the case.

The main purpose of this study is to explore the impact of HoloLens-based teaching on students' learning experience and learning performance.

- Experimental Subject

The sophomores of senior high school in Xinyang were selected as the experimental subjects. A total of 57 questionnaires were sent out, 41 of which were valid, including 21 in traditional classroom and 20 in a classroom where HoloLens is used (Fig. 9).

Fig. 9. After-class interview scene

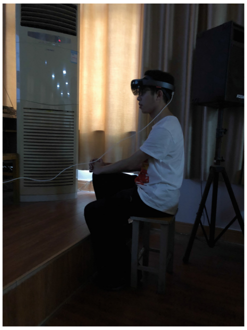


Fig. 10. Device experience teaching

- Research and Design

Experimental subjects are divided into two groups with the same number of learners. Random grouping and pre-questionnaires ensured that learners had the same initial state of learning. Both groups learned the same teaching content with the same teacher. In this study, group A is the control group, group B is the experimental group. The traditional teaching mode is used in group A, and mixed teaching mode are used in group B. Through the questionnaire survey and interview in the after-class, the difference of learning effect between the two groups was compared. Questionnaires can help us understand learners' learning situation in a wide range. Interviews can help us to get a deeper understanding of learners' learning stage (Fig. 10).

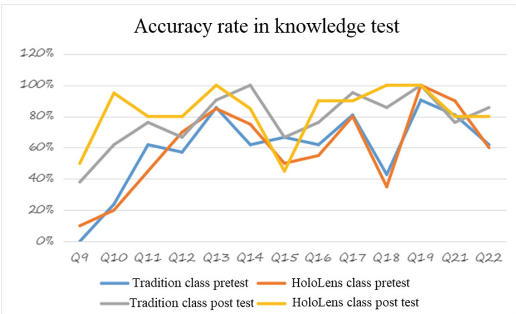
- Research Results

The result of the pre-test and post-test questionnaire is analyzed (measured by the correct rate). Overall analysis results (Table 2):

Table 2. Analysis of the results of pre-test and post-test questionnaire

Accuracy Rate	Q9	Q10	Qll	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q21	Q22
Tradition class pretest	0%	23.81%	61. 90%	57.14%	85. 70%	61. 90%	66. 67%	61. 90%	80. 95%	42. 86%	90. 48%	80. 95%	61. 90%
HoloLere class pretest	10%	20%	45%	70%	85%	75%	50%	55%	80%	35%	100%	90%	60%
Tradition class post test	38%	61.90%	76.19%	66. 67%	90. 48%	100%	66. 67%	76.19%	95. 24%	85. 71%	100%	76.19%	85. 71%
HoloLervs class cost test	50%	95%	80%	80%	100%	85%	45%	90%	90%	100%	100%	80%	80%

Table 3. Broken line diagram of correct rate of knowledge points



In most cases, the accuracy curve of HoloLens class post-test is higher than traditional classroom post-test curve, which indicates that the students in the interactive class finally understand the knowledge better than the traditional classroom. It can be seen that the improvement of the correct rate of students in interactive class is greater than that in the traditional class (Table 3).

As for the interview, most students think that the explanation is more thorough, more impressed, more innovative, more interactive and easier to understand. The spatial thinking ability of students is better when the augmented reality technology is used in class.

They also put forward the shortcomings of applying Augmented Reality technology in teaching. There will be obvious shaking when wearing the equipment, which is not conducive to eyesight, therefore the equipment is not suitable for using too often (Table 4).

Table 4. Analysis of the results of interviews

Advantages of using HoloLens	Disadvantages of using HoloLens
Deep impression	Obvious sloshing of the device
Strong sense of novelty	Damage to eyesight
Strong interaction	Insufficient depth and breadth of teaching
Improvement of Spatial thinking ability	Too much attention to the device

5 Conclusion

This paper proposes a multimodal virtual reality fusion display teaching mode based on HoloLens. The dynamic teaching environment of high school geography teaching is constructed. The gesture, voice, holographic interaction and viewpoint tracking technology in this technology are used to realize the teaching mode of 3D scenes, audio, images and videos teaching display and interaction. According to the comparison between before-class and after-class correct rate of interview results, the mixed teaching mode is suitable for the learning of abstract knowledge. Compared with the traditional teaching mode, the correct rate of test is higher. The initiative of students is also improved. It has good application value.

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Online Learning and Teaching Resource Management System Based on Virtual Reality Technology

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Abstract. The purpose of digital media art, relying on the Internet, is the creation based on the digital technology. The works created by students majoring in digital media arts have strong interactivity. Based on the course "An Introduction to digital media arts", this paper designed and developed an online learning and teaching resource management system based on virtual reality technology. This paper studied the blended mode based on this system and discussed the basic process and carried out the pilot teaching experiment. The experimental results showed that, compared with the traditional teaching model, using this system to implement blended teaching in the course that lays emphasis on the combination of theory and practice can not only realize the iterative renewal of teaching resources, reduce the burden of teachers, but also help students integrate knowledge and skills, and improve the ability to solve problems.

Keywords: Online learning · Teaching resource management · Blended teaching mode · WebVR technology · Digital media arts

1 Introduction

With the rapid development of computer and Internet technology, people are gradually entering the digital era. Creative industry with digital content as the core has become a key development field. "Digital Creativity" is the trend of the development of digital media arts major in the future. It is particularly important to speed up the construction of creative talent team [1]. The major of digital media arts therefore has received more and more attention in college education. Among them, "An Introduction to Digital Media Arts" course, as a required course of professional quality education for digital media arts major, plays a decisive role in the width and breadth of students' professional development in the future. The course content mainly includes the development process of digital media and the combing of knowledge in related areas. They are discussed from four aspects: technology, art, application and trend. The main feature of digital media art is the integration of technology and art, which makes the works diverse, virtual and highly interactive. Students should not only master the theoretical

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knowledge, but also constantly understand the frontier technology, and have the practical ability to create digital media works [2]. In the process of teaching, teachers should keep pace with the times, renew their own knowledge system, change teaching methods and modes, and make new teaching resources on the basis of sorting out the teaching resources needed by the curriculum, which undoubtedly increases the burden on teachers. Moreover, the works created by students in the process of education have not been well managed and cannot provide reference for the next student. Therefore, most of the repetitive teaching exists in teaching, and the availability of digital resources is not high. Students can't integrate abstract concepts with creation in practice, which reduces the teaching effect and has a great impact on students' future professional development.

Subsequent paragraphs, however, are indented. With the maturity of virtual reality (VR) technology, it has been widely applied in various fields. WebVR is a kind of virtual reality technology based on browser/server architecture. It belongs to lightweight VR, which is the product of the combination of virtual reality technology and Internet technology. Without installing additional software, the switch from 2D web pages to immersive virtual environment can be achieved with one click in any device browser that supports WebVR, making it easier for people to get virtual reality experience. WebVR makes up for the shortcomings of current common VR products, such as heavy equipment, fixed usage scenarios and difficulties in networking interaction, and is increasingly used in virtual communities, games, maps and other fields. The application in education mainly includes teaching environment display, virtual demonstration teaching content and virtual experiment [3]. The biggest characteristic of WebVR is that it can be spread and shared through the Internet, which can enable a large number of students to participate in it and gain immersive experience. At the same time, virtual reality, as a part of the teaching content of digital media arts major, is the knowledge that students must master. The development of online learning and resource management system by using WebVR technology can not only enable students to master the necessary VR knowledge, but also provide a display platform for multi-type works of digital media arts major. In the intuitive teaching experience, it promotes students to construct a good knowledge system and provides a new way for the spread and sharing of resources.

In order to solve the above problems and improve the teaching effect, this paper designed and developed the online learning and teaching resource management system, based on the constructivism theory, and designed the blended teaching mode with the system as the auxiliary, the teachers as the teaching guidance and the project system as the learning activity. In order to verify the educational applicability of the teaching model, a pilot study was carried out. The results showed that the blended teaching mode could create a relaxed and pleasant teaching situation for teachers and students. Students can actively participate in teaching activities. It realized the guidance of the teaching process, the co-construction, sharing and classified management of teaching resources. It can effectively improve students' understanding and mastery of knowledge, promote students' problem solving ability and reduce teachers' teaching burden.

2 Literature Review

2.1 "An Introduction to Digital Media Arts" Course

"An introduction to digital media arts" course, as a compulsory course for digital media arts major, is a course that combines theoretical teaching with student practice. On the one hand, as an emerging discipline, digital media arts major has not yet formed a mature education system and teaching mode and partial to more discussion the practice. According to Yang [4], the "workshop" teaching model is an effective attempt of talent cultivation in the education of digital media art, which can cultivate students' innovative consciousness and improve their social communication ability and adaptability. However, the study did not mention the degree of students' mastery of theoretical knowledge and how to carry out the teaching of theoretical knowledge. In the digital media art major of Nanjing University of Posts and Telecommunications, there are two teaching methods, namely, studio and industry-university-research plus competition, which can strengthen students' professional accomplishment and improve their practical ability [5]. However, Most of the students only design for the purpose of participating in the competition. They do not have a clear understanding of the professional development, and the school has not established a sound management mechanism for the works of students'. On the other hand, as a multi-disciplinary subject, digital media art is short of professional teachers. Teachers should not only receive re-education and learn digital media technology, but also prepare teaching content and achieve teaching objectives. Teachers are under great pressure in teaching and are likely to neglect the cultivation of students' comprehensive abilities [6]. Digital media art is an interdisciplinary subject. Research shows that communication, coordination and knowledge sharing have significant effects on the efficiency and effectiveness of teaching [7]. Project-based learning, as one of the effective strategies to promote students' collaborative communication and improve students' problem-solving ability, has attracted the attention of many scholars, but how to implement it to achieve the desired teaching effect remains to be further studied [8]. Therefore, this paper designed a new teaching mode, using online learning and teaching resource management system based on virtual reality technology to assist teaching, and explored the impact of blended mode on students' professional accomplishment and practical ability.

2.2 Digital Media Resource Management System

Digital media art is a new direction of educational technology. It mainly studies how to use digital media to create and express works artistically. The works have strong interaction and virtuality. Therefore, a large number of digital media resources have been accumulated in the teaching process of digital media arts major, but it is still very difficult to effectively use and share resources. Developing teaching application assistant teaching by using advanced digital media technology is increasing day by day. VR video is only used in teaching as resources, it didn't realized the management and sharing of resources. The system constructed by VR technology is mostly used in virtual experiment teaching, and there is little research on resource management.

Mysticraft realizes the management of resources, facilitates teachers' teaching and improves students' interest in learning [9]. However, the resources in the application software are suitable for primary and secondary education, but not suitable for the teaching of digital media arts. There are mainly three types of teaching resource management systems applied in digital media teaching: (1) browser/server architecture. Related research has proved that the digital media resource management system based on browser/server architecture can effectively manage digital media resources and improve the storage quality and retrieval efficiency of digital media resources [10]. However, the system only realized the management of resources. It did not really combine the characteristics of visualization, diversity and comprehensiveness of professional works of digital media art, and the experience effect is not good. (2) client/server. Relevant studies have proved that the safety and convenience of media management have been improved. Teachers can provide rich media teaching resources for students in the teaching process [11]. However, most of them are used in local area network, which is suitable for the fixed population. Students can only duplicate resources after class, which is affected by the size of resource files and the capacity of mobile devices. The degree of resource sharing is low [12]. (3) MOOC, Sakai, Blackboard and other learning content management systems are used to assist teaching. The learning content management system integrates teaching, learning and management, assists the development of teaching activities, realizes the management of teaching resources, and improves teaching efficiency. The research proved that the teaching media resource management system is more standardized, scientific and intelligent, and realized the effective management of teaching media resources [13]. However, this kind of system is suitable for courses with good knowledge structure to improve teaching efficiency. It does not really combine the characteristics of digital media art works and the differences of students' cognitive styles. Therefore, this paper combined the characteristics of digital media art professional works and students' cognitive style, used WebVR technology to develop online learning and resource management system for hybrid teaching and realize the visual management of resources.

3 Methods

3.1 System Design

The main development directions of digital media arts major are graphic design, illustration, photography, 3D modeling, animation production and advertising design. The system adopts with WebVR technology. Its characteristics are as follows: using the familiar web page mode, we can experience it in the browser that supports WebVR, the operation is simple and easy to use; it can create a virtual environment of intuitive experience and strengthen the interaction between students and resources; fast spread speed, long resource storage time and easy to manage. The system has two main functions: resource visual display and resource classification management.

(1) Resource visual display. Create a virtual display space in the system and divide the display area according to the type of works. The system is mainly divided into

three areas: pictures, videos and models. The picture area is divided into four parts: graphic design, illustration, photography and panorama; video can be divided into four parts: camera shooting, advertising design, animation and film and television production; model area is divided into several areas according to different categories. Teachers and students will arrange resources in the display area according to the type and set up the corresponding work information and display type. The video presentation of one of the groups is shown in Fig. 1(a).

(a) (b)

Fig. 1. System working effect interfaces.

(2) Resource classification management. Teachers have two main functions: one is to release the teaching process and tasks according to the teaching content, so that students can understand the development of teaching activities; the other is to classify and manage the resources and select the corresponding visual display of resources. The main functions of students are also divided into two parts. One is to upload and display the selected resources according to teachers' teaching tasks. Second, students manage their own resources in the course of independent learning and form learning records, which can share with others in the virtual space. Teaching resource management is shown in Fig. 1(b).

This paper took 7.8 Virtual Exhibition and Digital Museum in "An Introduction to Digital Media Arts (Third Edition)" compiled by Li Sida as an example to carry out blended mode teaching. In the virtual museum created by teachers, the video, pictures and so on collected by students about digital museum were displayed in a variety of interactive ways. Let students truly experience the museum's "people-oriented" concept and the development trend of future digital exhibition interaction and experience in the virtual scene.

3.2 Teaching Scheme Design

Based on the research of project-based teaching and the strategy of promoting problem solving, this paper designed a blended teaching mode. Teaching activities were divided into three stages: pre-class, in-class and after-class, including preparation before class, project identification, making plan, brainstorming, creation of works, presentation, evaluation, migration and recording at any time. The teaching mode is shown in Fig. 2.

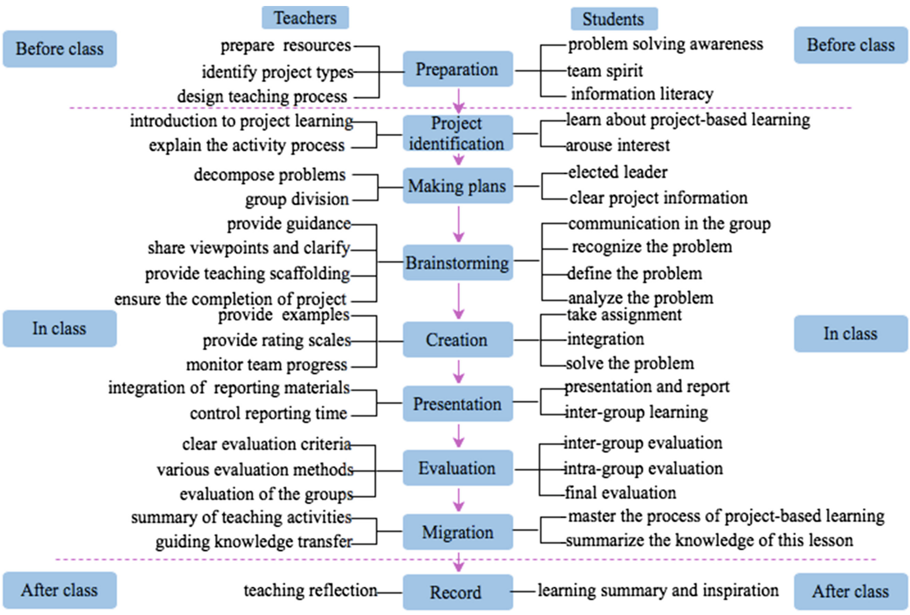

Fig. 2. Teaching scheme design.

(1) Preparation. Teachers design the teaching process and display the resources in virtual space. Identified the project to be carried out in the course, that is, find the resources about digital museum and design the display form of resources in the system. Students should have the corresponding awareness of problem solving, group cooperation and information literacy. (2) Project identification. Teachers need to introduce to students what project-based learning is, clarify the process of activities and show students the teaching resources prepared before class, so as to let students understand project learning and arouse students' interest. (3) Making plans. Teachers decompose the project in detail and break down the complex problems into simple problems, such as what are the digital museums, what is the suitable display form and let students understand the specific task of the project. At the same time, the group was established. This class was divided into five groups with six members in each group, so as to make plans, clarify division of labor and accelerate the project. (4) Brainstorming. Students brainstorm and discuss the project in groups, so as to recognize the problems in the project, identify and analyze the problems. During this period, teacher helped to sort out the problems according to the discussion of each group, gave guidance suggestions and provided corresponding teaching scaffold. (5) Creation. After analyzing the problems, students clarify the division of work of each classmate according to the specific problems, and finally carry out unified integration, so as to solve problems. During the creative period, teachers will provide various examples for students to refer to, give the results evaluation scale and monitor the progress of each group. (6) Presentation. Teachers integrate the presentation content provided by each group to convince learning among groups. In the report, it is necessary to control the reporting

time of each group. Among them, many small reports will be inserted in the process of creation, so as to facilitate the correction of the direction. (7) Evaluation. On the basis of teachers' clear evaluation criteria and methods, students conduct inter-group evaluation, intra-group evaluation and overall evaluation of production. (8) Migration. At the end of the project, the teacher summarizes the teaching knowledge of this lesson and guides the transfer so that students can apply it to their future study or other courses. (9) Record. The teacher reflects on the whole teaching process. Students write down what they have learned in this project and form their own learning growth record.

3.3 Participants

A total of 60 students whose major was digital media art participated in this study. None of the students had previous experience of WebVR related courses, and they were all beginners. A total of 30 students in one class were assigned to be the experimental group (group 1), and 30 in the other class were the control group (group 2). The two classes were taught by the same instructor, a male teacher with more than four years of college teaching experience.

3.4 Measure Tools

The paper used a quasi-experimental design. The independent variables were the two different teaching modes. The dependent variables were students' learning performance, problem solving ability and the workload of teachers. The measuring tools adopted in this study were the pre-test, the post-test and the questionnaire of students' problem solving ability. The pre-test aimed to assess whether the basic knowledge of the students of the two groups was equivalent before they participated in the learning activity. The post-test consisted of six matching items (Q1-Q6), assessed their comprehension of the connotation and trend of virtual exhibition and digital museum. The assessment items were developed by two experienced teachers, and corresponded to the learning content in the experiment. Five-point Likert scale was used in the questionnaire. Questionnaires measuring students' problem solving ability included 18 questions (T1-T18) and 6 dimensions (D1-D6). Among them, D1 was the ability to recognize problems, D2 was the ability to define problems, D3 was the ability to analyze problems, D4 was the ability to solve problems, D5 was the ability to reflect on problems and D6 was to expand the application ability of knowledge learned. At the same time, teachers and randomly chosen students were interviewed.

3.5 Data Collection and Analysis

The collected data were classified into quantitative and qualitative data. For the quantitative data, Independent sample t-test was used to test the learning effect of the two groups. One-way ANOVA was used to measure whether there was a significant difference in students' problem solving ability. Qualitative data included interviews with teachers and students to see how the two groups of students feel about learning this lesson and the attitude of teachers and students towards this system. In addition, the reliability was higher than 0.7, indicating that the reliability of the questionnaire was acceptable.

4 Results

4.1 Learning Performance Assessment

The two sets of data were from different groups of students. They were uncorrelated and mutually independent. Therefore, independent sample t test was used to analyze the results of the questionnaire survey. First, we calculated the mean and SD of the results of the questionnaire, as shown in Table 1. The pre-test column showed the test results of students' comprehension of virtual exhibition and digital museum before teaching; the post-test column showed the test results of students' comprehension after the pilot study. The pre-test results showed that there was no significant difference between group 1 and group 2; that is to say, the cognitive level of the two groups of students on virtual exhibition and digital museum was the same and they did not have a clear comprehension of the concept and development trend of the digital museum. On the other hand, the post-test average of group 1 was higher than 4.0 and that of group 2 was also higher than 3.0. It showed that the students' cognitive level of the virtual exhibition and digital museum has been significantly improved. Meanwhile, the mean of each question in the group1 was higher than that in the group2, indicating that the online learning and teaching resource management system based on virtual reality technology had better teaching effect.

Table 1. Pre- and post-test results comparison for groups 1 and 2.

No.	Group	Pre-test				Post-test			
		Mean	SD	F	p	Mean	SD	F	p
Q1	1	2.50	1.049	0.440	0.828	4.00	0.756	1.000	0.009
	2	2.33	1.506			3.00	0.535		
Q2	1	3.00	0.756	1.466	0.812	4.50	0.756	0.119	0.004
	2	2.88	1.246			3.25	0.707		
Q3	1	2.00	0.632	2.703	0.765	4.50	0.756	0.887	0.002
	2	2.17	1.169			3.13	0.641		
Q4	1	3.00	1.414	3.581	0.787	4.38	0.518	3.965	0.008
	2	3.17	0.408			3.25	0.886		
Q5	1	2.67	1.366	1.373	0.799	4.75	0.463	2.800	0.001
	2	2.83	0.753			3.50	0.756		
Q6	1	2.50	0.837	0.000	0.734	4.25	0.463	2.455	0.005
	2	2.33	0.816			3.13	0.835		

Then, the Levene test of the variance equation was used to determine whether there was a significant difference in knowledge understanding between the two groups. The post-test results of digital museum construction (Q1, $F = 1.000$, $p = 0.009 < 0.01$), digital museum concept (Q2, $F = 0.119$, $p = 0.004 < 0.01$), digital museum research hotspot (Q3, $F = 0.887$, $p = 0.002 < 0.01$), future exhibition development trend (Q4, $F = 3.965$, $p = 0.008 < 0.01$), future exhibition display form (Q5, $F = 2.800$, p = 0.001 < 0.01) and key technologies of future exhibition (Q6, F = 2.455, p = 0.005 < 0.01) showed that group 1 was significantly superior to group 2.

4.2 Problem Solving Ability Assessment

Independent sample t test was used to measure the difference of problem solving ability between the two groups and the results are shown in Table 2. The results showed that the mean value of group 1 was higher than that of group 2, especially in D1 recognize the problem, D5 reflect on the problem and D6 expand the application ability, group 1 was significantly higher than group 2. The independent sample t test results showed that students in the experimental group were more likely to recognize the problem (D1, F = 1.453, p = 0.000 < 0.001), define the problem more clearly (D2, F = 26.989, p = 0.000 < 0.001), analyze the problem more comprehensively (D3, F = 1.254, p = 0.005 < 0.01), solve the problem effectively through practice (D4, F = 2.125, p = 0.012 < 0.05), reflect on the problem (D5, F = 5.166, p = 0.000 < 0.001), and better at association, expand applications (D6, F = 0.916, p = 0.000 < 0.001). In conclusion, there were significant differences between group 1 and group 2. The students in the group 1 showed higher problem solving ability.

Table 2. Independent sample t test results of group 1 and group 2.

No.	Group	Mean	SD	F	p
D1	1	2.50	1.049	0.440	0.828
	2	2.33	1.506		
D2	1	3.00	0.756	1.466	0.812
	2	2.88	1.246		
D3	1	2.00	0.632	2.703	0.765
	2	2.17	1.169		
D4	1	3.00	1.414	3.581	0.787
	2	3.17	0.408		
D5	1	2.67	1.366	1.373	0.799
	2	2.83	0.753		
D6	1	2.50	0.837	0.000	0.734
	2	2.33	0.816		

Then, the data of group 1 were analyzed by one-way ANOVA, and the differences among the groups were compared. The results is shown in Table 3. The results of D1-D6 variance homogeneity Levene test showed that the data are more than 0.05, which indicates that variance homogeneity can be used for variance analysis. ANOVA results showed that there was no significant difference among the groups in recognize the problem (D1, F = 0.742, p = 0.573 > 0.05), define the problem (D2, F = 0.136, p = 0.967 > 0.05), analyze the problem (D3, F = 0.718, p = 0.588 > 0.05), solve the problem (D4, F = 0.357, p = 0.837 > 0.05), reflect on the problem (D5, F = 0.198, p = 0.937 > 0.05) and expand application (D6, F = 0.599, p = 0.667 > 0.05), so the problem solving ability of students in the group 1 has generally been greatly improved.

Table 3. One-way ANOVA analysis of problem solving ability of each group in the group 1.

Levene test		ANOVA	
		F	p
D1	0. 835	0.742	0.573
D2	0.375	0.136	0.967
D3	0.710	0.718	0.588
D4	0.765	0.357	0.837
D5	0.627	0.198	0.937
D6	0.486	0.599	0.667

4.3 Interview Results

Regarding the attitudes of students, most of the students in the group 1 believed that the online learning and teaching resource management system based on virtual reality technology created a visual, relaxed and pleasant teaching situation and promoted the understanding and mastery of abstract knowledge. Through project-based teaching, students can actively participate in teaching and improve their abilities in practice. At the same time, teachers felt that the blended teaching mode assisted by the teaching system was convenient for teaching and can spend more time on the design of teaching activities. While the students in the control group expressed the hope that they could get guidance to help them understand the teaching content. According to their own cognitive level, they could not fully understand the knowledge taught by the teacher, the content in the book, and the real meaning of the case to be expressed. The students in the control group hoped to have more auxiliary tools and methods to help their learning, and they were also willing to use the online learning and teaching resource management system based on virtual reality. The students in the experimental group also expressed their willingness to continue using it. Through the analysis of interviews, most teachers and students believed that the online learning and teaching resource management system based on virtual reality technology has four main characteristics: the system was easy to use; using virtual reality technology to build a realistic virtual environment can express good visual effects and create a relaxed and pleasant teaching situation. Resource classification management was convenient to improve the availability of resource construction and have long-term benefits. The visualization of resources enabled students to have intuitive experience, facilitate the understanding of abstract knowledge and was very meaningful for the presentation of works. In addition, they also mentioned the methods to improve the system design: appropriate interface design, the improvement of system functions, the construction and management of other professional curriculum resources.

5 Discussion

In this section, the influence of online learning and teaching resource management system based on virtual reality technology on learning performance and students' problem solving ability in the course of "An Introduction to Digital Media Arts" was discussed. The results showed that using this system to carry out project-based teaching could improve learn performance and improve students' problem solving ability. This is mainly due to assistive systems that make cognitively difficult abstractions visible. Through intuitive experience, improve the interest of students in learning, deepen their understanding of knowledge and improve the quality of teaching [14]. Students collected information about digital museums, designed display forms for collecting information and arranged them in digital museums. It was very difficult for students to design and develop a museum independently, but in the process of making a digital museum, they can apply the knowledge they have learned to the complicated problems that have been decomposed and experience the complete project design and development process while solving each small problem. Brainstorming in groups can recognize problems from different perspectives, identify problems, analyze problems comprehensively, and promote their team cooperation ability. In the process of division of labor and cooperation, teacher should correct students' thinking direction by means of stage reports of achievements, prompt students to reflect and truly solve problems, so as to apply what they have learned, achieve the goal of "learn by doing" and improve the participation of teaching activities and problem solving ability [15]. The application of WebVR technology integrates VR technology with Internet thinking and digital media art education, which conforms to the characteristics of digital media arts major keeping up with the trend of the times and changes the way of works spread. It can not only enable students to understand the frontier science and technology, transfer and apply the knowledge they have learned, but also facilitate the creation and spread of students' works [16]. These works not only rely on visual design to attract the attention of the audience, but also rely on multi-interaction and multi ways of expression to deepen the memory of visual transmission of information and realize the function of spread.

In addition, the application of online learning and teaching resource management system realized the classified management of teaching resources, which not only reduces the burden of teachers, but also facilitates the iterative renewal of resources. With the development of teaching process, the number of resources is increasing, and the teaching resources of digital media arts major are constantly changing with the development of digital media technology. Teachers need to sort out a large number of resources with variety types. By classifying resources, students can see the changes of resources and teachers can avoid repetitive teaching work and promote teaching efficiency. It can not only improve the availability of resources, but also reduce the burden on teachers.

6 Conclusion

The main purpose of this paper was to explore the influence of the application of blended teaching mode in the course "An Introduction to Digital Media Arts", which was assisted by the online learning and teaching resource management system based on virtual reality technology, with teachers as the teaching guide and project system as the learning activity, on students' learning effect and problem solving ability. The experimental results showed that the blended mode can correct students' learning attitude, deepen their understanding and mastery of knowledge, improve learning performance and promote their problem solving ability. At the same time, the experimental results also showed that the online learning and teaching resource management system based on virtual reality technology can assist the development of teaching activities, realize the co-construction and sharing of teaching resources and reduce the burden of teachers. With the deep integration of Internet technology, digital media technology and education, the construction of digital media resource sharing platform plays a very important role in realizing education informatization. Using WebVR technology to build resource bases is in line with the characteristics of multidimensional, rich interaction, real-time, immersion and distribution of digital media art works. It is conducive to eliminating the boundary between art and technology and achieving the integration of art and technology. In addition to improving the online learning and teaching resource management system, it is necessary to integrate with more theoretical and practical courses to realize the comprehensive management of digital media teaching resources for our future work.

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A Mobile Game for Learning English Vocabulary with Augmented Reality Block Builder

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Abstract. English learning is an essential part in modern education, and English vocabulary development has been shown particularly important in English learning. Yet, learners often found the process of English vocabulary learning dry and tasteless. This paper explores the possibility of using mobile game and Augmented Reality (AR) technology to improve the experience of English vocabulary learning. Our mobile game allows learners to play and learn anywhere and anytime. It is a multi-player word-guessing game, where a player can construct a virtual figure for an English word using an AR block builder and other players can guess the correct word from the virtual figure using their imagination. Preliminary user evaluation showed that our game facilitates players' learning on English vocabulary and also fosters their creativity. We believe this game will help forming a learning community, which can serve as a stepping stone for more involved collaborative learning activities on English learning.

Keywords: Augmented Reality · English vocabulary learning · Educational game · Mobile game · Block builder

1 Introduction

English learning is an essential part in modern education. English is one of the most widely spoken languages across the globe. Many countries include English as a second language in their education system, and children are required to learn English at a young age; for example, children in China are required to learn English starting from Grade 3 of the national education system (Wang 2007); all or nearly all (at least 99%) primary school students in the European countries including Italy, Spain, Austria, Norway, Cyprus, Malta learnt English as a foreign language (Eurostat Statistics Explained 2018).

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English vocabulary development is particularly important in English learning. Huckin (1995) showed the main and biggest obstacle in second language acquisition is the lack of vocabulary knowledge. August et al. (2005) also found that students with slow English vocabulary development are likely to perform poorly on comprehending text and are at risk of being diagnosed as learning disabled.

Yet English vocabulary learning is often considered as a boring and tasteless process especially for learners growing up in the digital age (Yip and Kwan 2006). The reasons include that the learners have to memorize a large number of unfamiliar words and their spelling (Long 1996; Huyen and Nga 2003), and that the learners are typically asked to complete lots of rote learning of vocabulary activities (Yip and Kwan 2006). Education practitioners and researchers have devised methods for teaching and learning English vocabulary in a fun and attractive way, which includes using educational games (see, e.g., the work of Yip and Kwan (2006), Ashraf et al. (2014) and AlShaiji (2015), and references therein) and using the Virtual Reality technology (e.g., Chen (2016)) and the Augmented Reality technology (e.g., Lee et al. (2019)).

Pictionary. One of the educational games for English vocabulary learning is *Pictionary*, which is a board game played by a group of players. Pictionary is basically a word-guessing game, as follows:

1. One player called *describer* is given a *target word* corresponding to a category game card.
2. The describer sketches or draws a related picture without the words on a blank screen (e.g., paper or chalkboard).
3. Then, the other players called *decoders* try to guess the correct target word from the picture.

Pictionary and its variants were used in English vocabulary learning, e.g., Townsend and Collins (2009) and Bakhsh (2016). These games are lively and productive ways to associate a picture with a word; students will remember the target words they labored to visualize in the game even after a long time (Sökmen 1997). These games also enable students to make connection between the target word and other words from their own prior knowledge (Townsend and Collins 2009). Draw Something (OMG-POP, Inc. 2012) is an online version of Pictionary, which is a mobile application allowing players to play anywhere and anytime.

Augmented Reality in Education. Augmented Reality (AR) is a technology that enables computer-generated virtual 3D objects to augment the physical world, and the users can interact with the 3D objects like a real object on the screen of a mobile device with a camera. The survey by Billinghurst et al. (2015) showed different applications of AR, and an important application is education (Wu et al. 2013). AR enables the visualization of complex spatial relationships and abstract concepts, e.g., anatomical education (Thomas et al. 2010), and also enables the simulation of a learning environment that was not possible using other technologies, e.g., radiation-polluted environment (Chang et al. 2013). AR offers a lot of benefits in education: it engages, stimulates, and motivates students to explore learning materials from different angles (Kerawalla et al. 2006); it provides students different ways to engage with the content, and thus promote active learning and enhance learning experience (Garrett et al. 2018); and it fosters students' creativity and imagination (Klopfer and Yoon 2004).

Our Contribution. This paper explores the possibility of combining the benefits offered by Augmented Reality (AR), mobile learning, and the multiplayer educational game Pictionary in English vocabulary learning. We present the design of a multiplayer mobile word-guessing game with an AR Block Builder. Like Pictionary, players of a game include a describer and a number of decoders. The describer will be given an English target word in some difficulty level, and will be required to use the AR block builder to assemble a virtual figure for the target word using virtual blocks of different types and colors in a creative and fun way. Then, the decoders can observe the virtual 3D figure in different angles using AR and try to guess the correct English word with their imagination.

Preliminary user evaluation using a survey on 50 respondents including students, teachers and parents showed that our game facilitates players' learning on English vocabulary and also fosters their creativity. Our game is a fun and attractive way for learners to play and learn English vocabulary anywhere and anytime. We believe this game will help forming a learning community from the players, and such community can serve as a stepping stone for more involved collaborative learning activities on English learning.

1.1 Related Work

Using Educational Games in English Learning. Besides board games like Pictionary, educational games can also be implemented as video games and computer games. Yip and Kwan (2006) showed in an experiment on 100 college students that students learning English vocabulary through a number of educational web games outperformed those learning with conventional activity-based lessons using pre- and post-tests. Ashraf et al. (2014) showed a similar result for educational online games on 24 Iranian low-intermediate EFL (English as a Foreign Language) students. AlShaiji (2015) investigated the impact of educational video games on promoting the English vocabulary retention of 60 Saudi kindergarten students, and showed that video games are effective in teaching English vocabulary to the students. There is, however, existing work showing the opposite result. Calvo-Ferrer (2017) showed that the differences in L2 vocabulary acquisition between educational video games and conventional instruction are small. Yet they also showed that educational games increase students' extrinsic motivation in learning, as they are more attractive and fun comparing with conventional learning methods.

Using VR in English Learning. Virtual Reality (VR) is a technology allowing a user to see a virtual 3D world by wearing a VR headset, e.g., HTC Vive (www.vive.com), and to create, modify and manipulate virtual 3D objects like physical objects without real-world limitations by holding a remote controller (Bricken 1991). Chen (2014) developed a VR courseware for learning occupational English and showed that 120 freshmen and sophomore EFL students gradually increased their vocabulary competence via learning with the VR courseware. Chen (2016) considered the VR platform

Second Life, which is widely used in higher education (Warburton 2009), and showed how Second Life can serve as an online multiplayer learning environment for adult EFL learners and teachers to participate in virtual class activities.

Marker-Based and Markerless AR. AR is based on techniques developed in VR, but AR only requires a mobile device while VR requires both the VR headset and the remote controller. Therefore, AR offers greater portability and convenience than VR. Two primary types of AR implementations are marker-based and markerless AR (Siltanen 2012). Marker-based AR relies on a reader (e.g., camera) to read a special image called *marker* (e.g., QR code) to produce the virtual 3D objects; while markerless AR detects a surface in the camera image and produce the virtual 3D objects on top of the detected surface. Marker-based AR is easier to develop and provide a more stable environment for the virtual 3D objects, but the use of a physical marker makes it less convenient than markerless AR.

Using AR in English Learning. There are lots of existing work on using AR in teaching and learning of English vocabulary. AR-animals (www.ar-animals.com) is a marker-based AR mobile application for English vocabulary education, where the learning material is a book with markers of a price $18. Lee et al. (2017) showed the design of a markerless AR mobile application for kindergarten students to learn English vocabulary, and the mobile application has a monitoring system for parents to monitor and control children's usage in real time. Chen et al. (2018) developed a markerless AR mobile application for learning English vocabulary and an experiment on 46 primary students showed that the AR application can significantly improve students' motivation and learning effectiveness. Lee et al. (2019) showed how kindergarten teachers can apply a marker-based AR mobile application coupled with classroom management functionality in their English vocabulary lesson to make the lesson fun and attractive.

Organization of the Paper. Section 2 presents the design details of our multiplayer mobile word-guessing game. Section 3 gives the preliminary evaluation result. Section 4 discusses the evaluation result and concludes the paper.

2 Our Multiplayer Mobile Game

This section presents the detailed design of our multiplayer mobile word-guessing game. Our mobile game can be run on a mobile device with the operating system Android 4 or above, and equipped with a camera and at least 1 GB RAM of memory. Each player needs to play with his/her own mobile device. Our game was developed using the game engine Unity and the Vuforia Augmented Reality SDK. Our mobile game contains three components: an AR block builder (which requires a QR code as a marker), a word-guessing game, and a revision on history of games.

2.1 AR Block Builder

The AR block builder allows a player (describer) to assemble a virtual figure for the English target word using virtual building blocks of different types and colors in a creative and fun way. It employs marker-based AR and requires the mobile device's camera to read a QR code image (Fig. 1) as a marker, and then a virtual *assembly area* for the building blocks will be displayed on top of the marker (Fig. 2).

Fig. 1. Our AR marker.

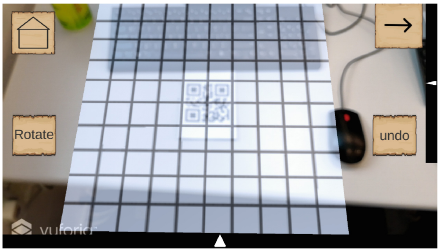

Fig. 2. Virtual assembly area for the building blocks.

The *building block panel* and the *color panel* are hidden in the bottom and right boundaries, respectively, in the user interface shown in Fig. 2. Pressing the white arrows in the boundaries invoke the corresponding panels (Fig. 3).

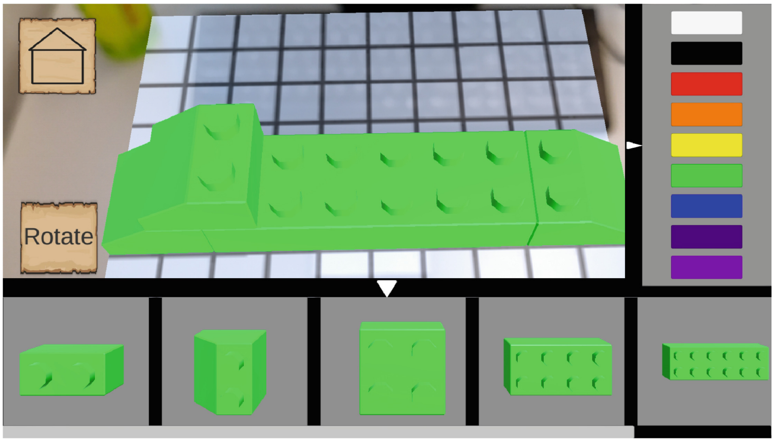

Fig. 3. Building block panel (bottom) and color panel (top-right).

Building Block Panel. The building block panel provides 6 different types of virtual building blocks in different sizes and shapes. Once the describer select a building block, he/she can click a location on the assembly area to place the building block there. If the describer clicks on an existing building block in the assembly area, the new building block will be placed on top of the existing one.

The user interface shown in Fig. 2 contains four buttons. The upper-left button is the *home button* for returning to the game menu page (to be introduced in the next subsection). Pressing the home button also triggers a prompt asking the user to save any unsaved work (if there is any). The lower-left button is the *rotate button* for rotating a building block by 90° clockwise. The lower-right button is the *undo button* for removing the most recently placed building block in the assembly area. The upper-right button is the *complete button* for completing the assembly of a virtual figure for an English target word. Pressing the complete button will prompt the describer to select a number of friends as decoders to play the game.

Color Panel. The color panel contains 9 different colors (white, black, red, orange, yellow, green, blue, violet, and purple). Pressing one of these colors will change the color of all building blocks shown in the building block panel.

As to be shown in the next subsection, the combination of different colors and types of building blocks allows us to assemble figures for different target words.

2.2 Word-Guessing Game

The word-guessing game has game rule similar to the game Pictionary. In each game, there is one describer, who is given an English target word and is required to assemble a virtual figure of the target word using the AR block builder. The other players are decoders, who try to guess the target word by observing the virtual figure in different angles and combining their imagination.

To ease connecting with friends, all players are required to login with their Facebook account (Fig. 4). After login, the game menu page is shown (Fig. 5).

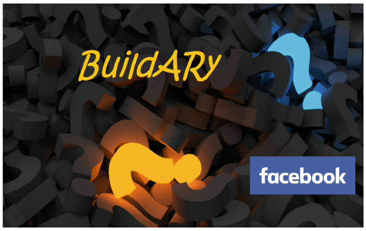

Fig. 4. Login page.

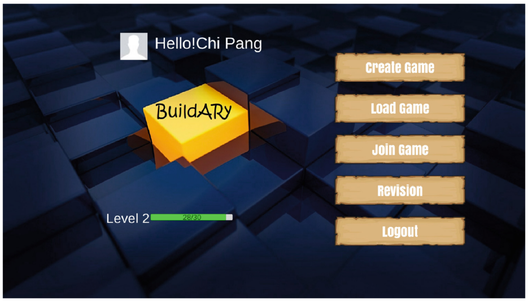

Fig. 5. Game menu page.

Create a New Game as a Describer. The player can act as a describer to start a new game using the *Create Game* button in the game menu. The player can choose vocabulary from three categories: Food, Animal, and Place (Fig. 6), and then select a target word in three difficulty levels: Easy, Medium, and Difficult (Fig. 7). It is also possible to use a custom target word. After selecting the target word, the player can build the virtual figure for the target word in the AR block builder.

Fig. 6. Categories of vocabulary.

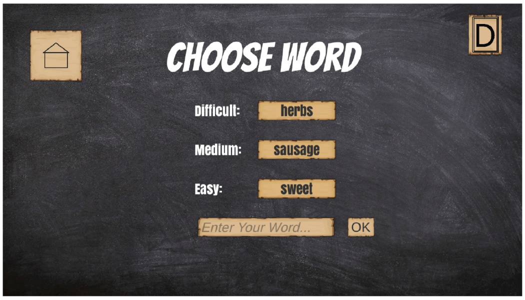

Fig. 7. Difficulty levels of vocabulary.

Load a Saved Game. A describer can quit the AR block builder anytime, and the virtual figure in progress can be saved. The *Load Game* button in the game menu allows the describer to continue the assembly of a saved figure.

Invite Decoders. When a describer completes the virtual figure for the target word (by pressing the *complete button* in the AR block builder), the describer can invite a number of friends from the Facebook friend list (Fig. 8) to play the game as decoders.

Join an Invited Game as a Decoder. The player can press the *Join Game* button to see the list of invited games created by other players. For each game, the category and difficulty level (Easy, Medium, Difficult, Custom) of the target word are shown.

Figure 9 shows the gameplay of a decoder for the target word "crocodile" under the category "Animal". Like the AR block builder, the QR code image is used as the AR marker. On the screen of the mobile device, the real-time camera image is overlaid with the virtual figure, which is placed on top of the AR marker. The size and direction of the virtual figure will change according to the player's movement of the mobile device such that the player can zoom in/out and view the virtual figure in different directions as if the virtual figure is a real object placed on top of the AR marker. In the bottom of the user interface, the mobile game will generate a number of character blocks, and the decoder is required to click the correct character blocks in the correct order and then click *OK* to check whether the game is completed correctly.

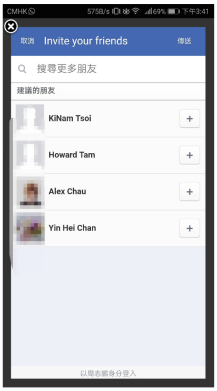

Fig. 8. Inviting decoders.

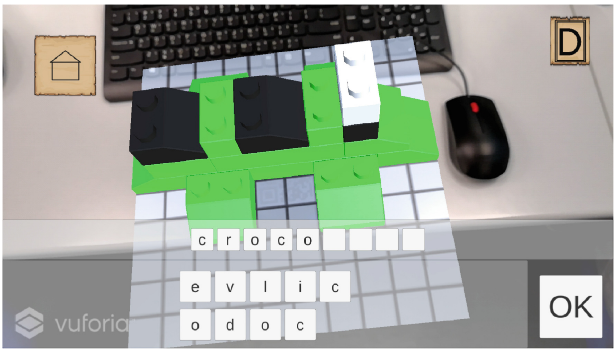

Fig. 9. Game for the word "crocodile" under "Animal".

The Power of Augmented Reality (AR). Different from the game Pictionary and its variants (Townsend and Collins 2009; Bakhsh 2016), our 3D virtual figure for the target word allows details to be hidden in different sides of the virtual figure. For example, it may be unclear that the virtual figure shown in Fig. 10 (left) is a “bedroom” under the category “Place”, but viewing it in another angle as shown in Fig. 10 (right) would make the answer clear when the decoder is able to identify the bed and makeup table, respectively.

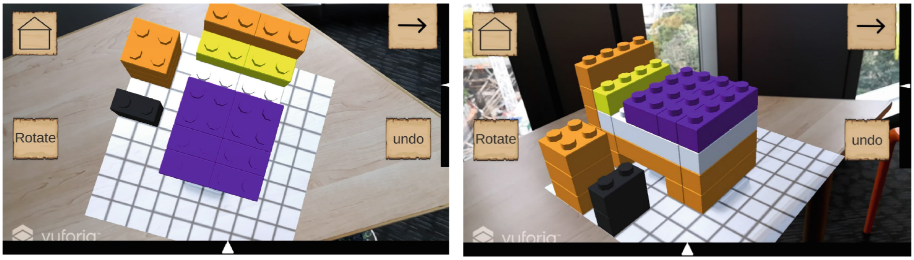

Fig. 10. Game for the word “bedroom” under the category “Place”.

The word “bruise” under the category “Food” refers to the damage mark on the skin of a fruit. Figure 11 shows that the bruise can only be found in some particular angle of the virtual figure; it can be seen in right figure but not the left one. We believed that the learners will find the game more fun and interesting when looking for such hidden details in the virtual figure from different angles of view.

Fig. 11. Game for the word “bruise” under the category “Food”.

Translator. A translator can be invoked in different parts of the game to facilitate learning. The player can press the “D” button in the user interface, e.g., Fig. 7 (when creating a game) and Fig. 9 (when guessing a word), and then the translator will be shown that supports translation from English to Chinese or vice versa (Fig. 12).

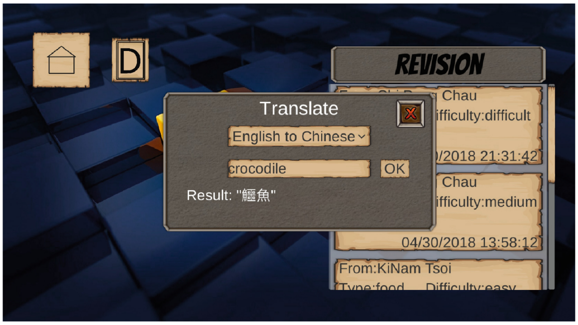

Fig. 12. Translator for translating words between Chinese and English.

2.3 Revision on History of Games

Inspired by the finding of Sökmen (1997) that students can remember the target words they labored to visualize in Pictionary even after a long time, our mobile game supports revision on previous games. This functionality can be assessed using the *Revision* button in the game menu (Fig. 5). Then, a list of previously played games will be shown as in Fig. 13. The target word, its vocabulary category and difficulty level is shown, and players can view the corresponding virtual figure again using AR.

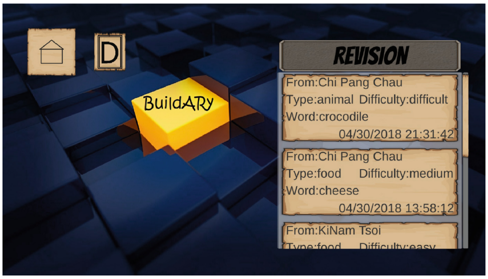

Fig. 13. Revision on history of games.

3 Preliminary Evaluation

This section presents the result of a preliminary evaluation on our game design from different stakeholders of English vocabulary learning.

Participants and Setting. We invited 50 participants including students, teachers and parents to complete an online survey. In the online survey, each participant is given a demonstration video introducing different functionality of our mobile game, an installation file of the mobile game that contains three pre-created invited games, and an online questionnaire to be filled after the participants view the demonstration video and/or play our mobile game on their mobile devices. Among the 50 respondents, 25 participants (50%) installed and played the game; the other 25 participants only watched the demonstration video because they don't have an Android device (n = 12, 24%), or they are not interested in playing the game (n = 11, 22%), or for other reasons (n = 2, 4%).

Results. The online survey used a 5-point Likert scale (1: strongly disagree, 2: disagree, 3: neutral, 4: agree, 5: strongly agree), which has 13 items related to game design (Items 1–4), gameplay (Items 5–9), and comparison with traditional learning methods (i.e., reading books and attending classes) (Items 10–13). Table 1 shows the results on the 25 game players, who answer all the items; and Table 2 shows the results on the other 25 non-players, who did not play the game and thus did not answer items for gameplay (Items 5-9).

Table 1. Survey result on game players.

Item	1	2	3	4	5
(1) The AR function attracts you to play the game	4%	4%	8%	76%	8%
(2) The game helps you to understand the vocabulary	0%	20%	8%	60%	12%
(3) The AR function helps promoting creativity	0%	8%	8%	68%	16%
(4) The UI is easy to use	4%	20%	8%	64%	4%
(5) The game control is easy	8%	28%	8%	48%	8%
(6) The vocabulary learnt is useful in daily life	0%	4%	4%	80%	12%
(7) The vocabulary has a suitable difficulty level	4%	8%	8%	68%	12%
(8) The translator helps you to learn more effectively	0%	8%	8%	64%	20%
(9) The revision is useful for reviewing learnt words	0%	4%	8%	68%	20%
(10) The game helps learning English	0%	4%	4%	80%	12%
(11) The game is more attractive than the traditional learning method	0%	20%	8%	52%	20%
(12) The game helps you understand a word better than using the traditional learning method	0%	16%	8%	60%	16%
(13) You prefer learning using the game over using the traditional learning method	0%	20%	8%	64%	8%

Table 2. Survey result on non-players.

Item	1	2	3	4	5
(1) The AR function attracts you to play the game	4%	32%	4%	56%	4%
(2) The game helps you to understand the vocabulary	4%	40%	0%	56%	0%
(3) The AR function helps promoting creativity	4%	20%	4%	68%	4%
(4) The UI is easy to use	4%	8%	4%	80%	4%
(10) The game helps learning English	4%	24%	0%	68%	4%
(11) The game is more attractive than the traditional learning method	4%	16%	4%	64%	12%
(12) The game helps you understand a word better than using the traditional learning method	4%	32%	4%	44%	16%
(13) You prefer learning using the game over using the traditional learning method	8%	40%	4%	36%	12%

4 Discussion and Conclusion

Table 1 shows that the majority of the game players agreed that the AR function is attractive and helps promoting creativity. The majority of the game players also agreed that the game helps them to understand the vocabulary, and the UI is easy to use. Yet, only 56% of the game players agreed that the game control is easy (Item 5). It may be due to the use of a physical QR code image as the AR marker; physical markers are consumable and would be damaged that greatly affects usability (Lee et al. 2017). For the remaining items, the majority of the game players agreed that the game and revision can help learning vocabulary and the vocabulary are useful in daily life and in suitable difficulty levels. They also preferred learning English vocabulary using the game over using traditional learning method.

Table 2 shows the survey result on non-players. Only 60% of them agreed that the AR function is attractive (Item 1), and only 56% of them agreed that the game is helpful in understanding the vocabulary (Item 2). Similarly, only 60% of them agreed our game helps learners to understand a word better than using traditional learning methods (Item 12), and only 48% of them preferred to use our game as learning tool over using traditional learning methods (Item 13). One reason for these negative results may be that 11 of these non-players (i.e., 44% of the non-players) are not interested in playing our game in the first place, and thus they do not try to install the game and actually try the functionality offered by our game. Nevertheless, aggregating both the game players and non-players, the overall majority of participants agreed on Items 1, 2, 12 and 13. For the remaining items, the majority of the non-players also agreed on them.

To sum up, this paper presented the design of a multiplayer mobile word-guessing game that combines the benefits offered by Augmented Reality (AR), mobile learning, and the multiplayer educational game Pictionary in English vocabulary learning. The preliminary evaluation showed that our game is a fun and attractive way for learners to learn English vocabulary and foster their creativity anywhere and anytime. The players of this game can form a community on English learning, and we believed that such community will be ready for more involved collaborative learning activities.

Limitation and Future Work. Our preliminary evaluation only provides limited information on the players' learning effectiveness on learning English vocabulary. A future work is to perform pre- and post-tests to compare the performance of learners using our mobile game and using the traditional learning methods as learning tool, respectively. Another direction of future work is to replace marker-based AR with markerless AR, which does not require a physical AR marker and is expected to improve the game experience of the learners.

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Open Online Courses and Open Educational Resources

Analysis of Forum Interaction Behavior Based on Cloud Class

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Abstract. The forum is one of the auxiliary tools for formal learning. Some studies have shown that students' performance in the forum is strongly related to their learning effectiveness. This study took the online forum posting texts in the blended class of Educational Technology Research Methodology as the research object. First, the literature analysis method was adopted to comb and analyze the related research, and the social network analysis method was used to find out the learners who participated in the interaction in the forum and characterize their features. Next, a statistical analysis tool was used to cluster the learners, thus they were divided into three types those were activists, followers, and silencers. Then, the correlation analysis was performed with the number of interactions between the three types of learners in the forum and the academic scores. Semantic analysis was used to analyze learners' emotions, and different learners' emotions were correlated with their academic performance. The study found that in the blended class, there was no significant correlation between the number of interactions among different types of learners and their course performance, and there was a significant correlation between the emotional coefficient and the course performance. Finally, this paper proposed some instructional strategies in the forum of blended class.

Keywords: Forum · Interactive behavior · Sentiment analysis · Blended class

1 Introduction

Interaction plays a key role in meaningful learning for learners [1]. Social interaction is one of the hot topics in the field of online education. Research mainly focuses on the characteristics and laws of social interaction, interaction quality, interaction strategies, and evaluation index systems [2]. The concept of social interaction was first proposed by the famous Canadian scholar Tony Bates, who believes that social interaction refers to the interaction between two or more members of the virtual community [3]. The study of Unicomism studies suggests that learning is the optimization of personal knowledge networks, emphasizing the formation of networks. The formation of the network includes two elements: nodes and connections [4]. The main form of node formation and connection establishment is interaction, including the interaction between people and people, people and resources, people and various technical means

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[5]. In 2005, Canadian scholar Siemens pointed out in Connectivism: A Learning Theory for the Digital Age that “Connectivism” integrates principles from chaos theory, network, complexity, and self-organization, and becomes a new type of learning theory in the digital age [6]. In the context of online learning, teachers increasingly value the construction of learning communities and encourage learners to learn interactively in the forums. The learning community precisely reflects the viewpoint of connectivism.

In the field of education, especially in the field of higher education, students master a higher level of knowledge and skills. They can form learning communities and use forums to answer questions or supplement learning and communication. However, whether the number of interactions between students in the forum and their academic performance is relevant, how the emotions expressed by the learners through the text are related to their academic performance, and how the teachers should make full use of the forum to promote the construction of learner’s knowledge when using the hybrid-teaching model. These problems need to be solved urgently.

2 Related Studies

As for the social network analysis method, Wise used the methods of social network analysis (SNA) and inductive qualitative analysis to compare social relationships and the underlying interactions they represent in discussions related and unrelated to the learning of course content in a statistics MOOC [7], which is very enlightening for my research. In addition, Zheng Qinghua, a Chinese scholar, has also done relevant research. He used social network analysis, content analysis and correlation analysis methods to analyze the interaction center degree and interaction quality of the bearers in the forum. The results is that there is no significant correlation between the quantity of interaction and the quality of interaction in the MOOCs curriculum, but the quality of social interaction at the beginning of the course will have a significant impact on the interaction level of the later academic process [8]. For the use of clustering method, many scholars have applied it to all kinds of research, and the research on forum is no exception. Scholars usually use clustering, probabilistic topic modeling, Word frequency analysis and other methods to excavate the topic types of forum text. For example, Chinese scholar Liu Zhi through probabilistic topic modeling and word frequency analysis, extract the hot topic of learning group interactive discourse process. Moreover, compared the amount of posts and emotional experiences (the difference between positive emotion and negative emotion) of learners with different learning effects in different time periods, and finally showed that the learners published topic posts and replies. The four behavioral variables of general post and post amount are related to their learning effect [9].

By comparing the results of unsupervised model clustering with those of manual annotation clustering, Aysu Ezen-Can et al. see the quality of model clustering and promote the accuracy of models. On this basis, the topic mining of different classes is carried out, so as to understand the topics concerned by learners more comprehensively [10]. In order to establish adaptive learning strategies, Ferguson et al. constructed a set of training model based on tagging features to automate the exploration of discourse types: inquiry dialogue and non-inquiry dialogue, and complete the binary classification of discourse in the forum [11]. This kind of research is very similar to the research by Liu Zhi and others. They all transition from simple behavioral data analysis such as click volume to discussion posts in the deep mining analysis of post content. Wen et al., through the analysis of the open platform of MOOC. Affective analysis is used to monitor the trend of learners' emotional evolution in the curriculum, and it is found that there is a significant correlation between the affective ratio and the withdrawal rate [12].

In summary, the current research on interactive learning forum is still in the exploratory stage, the researchers established a certain research ideas, but there is no established mature research methods. The analysis of the interactive text in the forum still stays in the study of the interaction quantity and interaction quality. Some scholars analyze the text according to the learner's emotion, but the research on the text semantic mining is not mature enough.

3 Research Programs and Implementation

3.1 Research Framework

In the context of online learning, for acquiring knowledge, interactions are usually conducted in the form of asynchronous forums. Text is the main carrier for information exchange and contains a large amount of information about the interaction process and knowledge construction process. Most studies have researched the relationship between learner interaction attributes (interaction number, posting time, interaction quality, etc.) and their learning outcomes from the perspective of learner interaction behavior. However, rarely from the perspective of actor type, perform portraits of different actors to examine whether there are significant differences in the academic performance of different types of actors. Moreover, whether there is a correlation between the emotions expressed by different types of actors through the text and their academic performance. The research framework of this study is shown in Fig. 1.

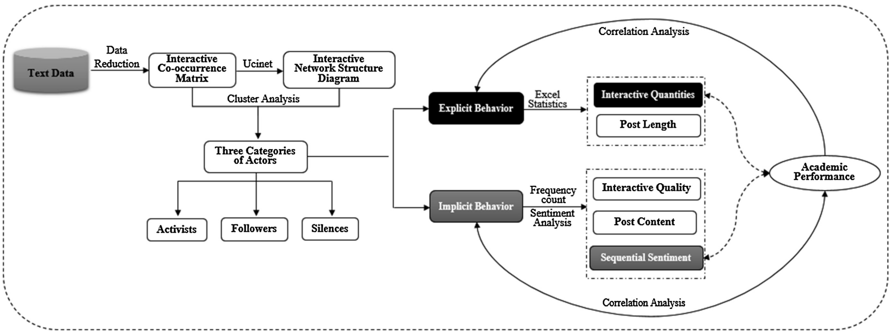

Fig. 1. Research framework of learning behavior in the forum

(1) All the actors participating in the forum interaction are clustered, and the social network analysis method is used to analyze the types of each player's category, including activists, followers, and silencers.
(2) The behaviors of the three types of actors are analyzed to make the portraits of the learners, mainly from the explicit behaviors and the implicit behaviors. The explicit behaviors are analyzed from the number of postings, the interaction coefficient, and the types of topics with more interactions. Moreover, the implicit behavior is mainly analyzed by the actor's posting content, and is analyzed from the following indicators: the type of posting content, and the emotional changes in the entire time series.
(3) Using the statistical analysis tools to analyze the correlation between the three different types of actors and academic performance, and the correlation between the emotional and academic performance of different actors in the posting content throughout the semester.

3.2 Research Objects

Cloud Classroom is an online learning platform independently designed and developed by the National Engineering Research Center for E-learning of Central China Normal University (CCNU). The platform provides students with a personalized learning experience and a free and open interactive communication environment. Teachers can freely deploy their own courses on this platform. The data of this research comes from the online interaction of the course Educational Technology Research Methodology, an academic postgraduate major in educational technology in the cloud platform of CCNU. The course focuses on developing students' ability to master scientific research methods and its time lasts for one semester. Teachers use a combination of online and offline teaching methods. The assessment method of the course is combined formative evaluation (class participation, frequency depth, etc. of students' participation in online interaction) with summative evaluation (writing of research proposal). The object of this study is the text content of 7 topics and 1334 online posts in one class (four groups) in the Cloud Classroom Forum. The data was generated from September 20, 2017 to January 6, 2018.

3.3 Research Methods

This research mainly uses literature analysis, social network analysis, semantic analysis, and quantitative analysis. From the perspective of "relationship", we study the seven themes of teachers' prescribed topics. Firstly, we use the literature analysis method to understand the related research status. Secondly, the method of semantic analysis is used to analyze the sentiment coefficient of learners' posting content. Thirdly, we use social network analysis to find out "activists", "followers", and "silencers". Finally, the method of quantitative analysis is used to analyze their correlation of the number of interaction, posting emotion coefficient and their academic performance, thus to explore whether the interaction characteristics of different actors and their academic scores are significantly related.

Social network analysis is a method to study the individual actors and their interactions and interaction patterns. It can visually construct the interaction between actors and present them in a graphical way [13]. This study uses social network analysis tools to construct a learner's interactive community map, identify members of the group's information provision and contact, and determine the network density, point center, middle center, and other parameters of the learner's interaction. The location and participation in the interactive network identify the core players and marginal participants.

Semantic analysis is a method of using the semantic region subscale to study the meaning of things [14]. Sentiment analysis is an analysis method based on semantic analysis, it is a common application in natural language processing methods, and the simplest form is the use of dictionaries containing positive and negative words, and the use of emotional assessment can achieve quantitative analysis of qualitative data. In this study, the method is mainly used to analyze the emotions of learners in the forum, and through the analysis of learners' emotions to study the relationship between their emotional engagement and their academic performance.

3.4 Statistics and Processing

After the course is over, the interactive data in the network learning space is collected, and the system log, post, replies, text information, sponsors, and time information are saved to an Excel file. In accordance with the format code of the social network analysis tool UCINET, a relation matrix is constructed to analyze the interactive social network structure and its network density and centrality in the network learning space. All the actors were clustered with SPSS, a data statistics and analysis tool. All the actors were divided into three categories: activists, followers, and silencers. Identify the typical actors of the three types of actors and analyze the number of interactions, interaction quality, emotions, etc., and perform correlation analysis with their learning outcomes to explore the behavioral characteristics of different actors, and to study whether there is correlation with their behavioral characteristics and learning effectiveness.

3.4.1 Interactive Network Analysis

The research object of this study is the post of middle school students who spoke in this course. "0926" in the theme of "0926 Question Determination" means September 26, and the last two themes mean the same in the figures. The teacher only acts as a topic sponsor in the interaction, and does not participate in the interaction process afterwards. Therefore, we can ignore the teacher's influence of the entire network and only analyze the student's interaction. The students participating in the interaction are mainly members of the same class with 23 students. Since the teacher has set up other classes of students can also make comments and replies, and in order not to change the structure of the entire interactive network, so in the process of the study, other classmates participate in the interaction assigned to the role of visitors, unified with X to represent.

Using Excel to establish interactive matrixes of 23 actors, the relationship matrix was imported into UCINET6.0, and using its integrated Netdraw tool, 23 actors' interactive community map were obtained, as shown in Fig. 2.

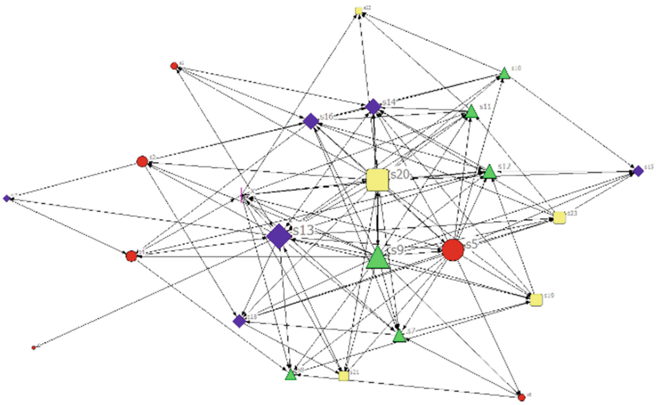

Fig. 2. Interactive community map of 23 actors

Social networks and community maps are two very important concepts in social network analysis. Social networks refer to social actors and their collections of relationships. Community maps refer to the diagrams of actors (represented by dots) and the relationships of the actors (represented by lines), that represent the relationships of group members. Wang believes that using social graphs can analyze which members of the group are the main information providers and liaisons [15]. From Fig. 3, we can see that s20 is at the center of this topic, indicating that it is active in the forum, likes to express its opinions in the forum, and is willing to communicate with other learners. In addition, the four active learners such as s5, s9, s13, and s20 are distributed in four groups, indicating that each group has a more active learner who participated in the forum discussion. The four learners are likely to be the leader of each group.

3.4.2 Actors Clustering

In Excel, the total amount of posts and total postings of all the actors in seven topics were collected. The SPSS tools were used to cluster the actors. The number of clusters was set to three, and the clustering results were shown in Table 1. The K-means clustering algorithm used in this clustering is a typical distance-based clustering algorithm. Distance is used as the evaluation index of similarity, that is, the closer the distance between two objects is, the greater the degree of similarity is. In the first step of the K-means algorithm, any k objects are randomly selected as the center of the initial cluster and initially represent a cluster. The algorithm reassign each object to the nearest cluster according to its distance from each cluster center for each of the remaining objects in the dataset during each iteration. When all data objects have been examined, an iterative calculation is completed and a new cluster center is calculated. If there is no change in the value of J before and after an iteration, the algorithm has converged. Its formula is:

$$V = \sum_{i=1}^{k} \sum_{x_j \in S_i} (x_j - \mu_i)^2$$

In this study, the author divided all actors into three categories: activists, followers, and silencers. An active person refers to an actor who posts a large number of posts in a forum. A follower refers to an actor who posts fewer posts in the forum. A silent actor refers to an actor who posts a small number of posts in the forum. As can be seen from Table 1, in the "0926" theme post, the first type of cluster center is 28, which represents the actor with 28 times of interactions in the theme post, identified as "activists", and the second category is identified as "followers", and the third category is identified as "silencers".

Table 1. Actor Clustering Results

Theme posts	Clustering results		
	1	2	3
0926	28	17	8
1017	11	23	9
1107	20	18	7
1114	42	18	13
1128	19	8	7
1205	20	12	8
1212	20	4	5
Total posts	160	99	57
Number of cases	3	7	13

In this study, the authors were classified by the total number of posts posted by the actors in seven themes. According to the clustering results in Table 1, the number of activists is three, the number of followers is seven, and the number of silencers is 13. Therefore, it can be seen that in the current semester of this course, the interaction of learners in the forum is not active enough, and the proportion of silent persons reaches 56.5%. Teachers should implement the intervention measures to the learners in a timely manner and promote the interaction of the learners, so as to promote the learner's construction of the meaning of knowledge.

4 Results and Discussion

4.1 Explicit Behavior Analysis

Explicit behavior is a term used in behaviorist psychology. Watson, the founder of behaviorism, denies psychology or consciousness and identifies psychology as behavior. He thinks that behavior can be divided into explicit behavior and implicit behavior [16]. Explicit behavior refers to behavior that is easily observed by others directly through external actions. People's thoughts, feelings, and mental states are revealed or expressed by means of external actions. When such exposure or expression is conscious and becomes the psychological activity and personality of others who can perceive and judge the revealer or expresser, psychologists call it explicit behavior [17]. In the context of online learning, explicit behavior of learners in the forum is mainly reflected by their interactive attributes such as the number of postings, length of posts, posting time, and interactive relationships.

4.1.1 Analysis of Network Structure Characteristics of Different Themes Network

Density is the most commonly used indicator to measure network connectivity. The larger the network density is, the closer the relationship between the members of the network is, and the greater the influence the network may have on the attitude and behavior of the network actors. Centrality is generally used to measure whether a single actor is centrally located in the network. The three commonly used network centers include point centering, intermediate centering, and near centering. The point centering describes the actor's local center index, which is used to measure the actor's own interaction ability in the network. The intermediate centering describes the extent to which an actor lives between the other two actors and is an index of resource control capabilities. The near centering is the opposite of the intermediary center, which considers to what extent an actor is not controlled by other actors.

Table 2 shows that over time, the network density and clustering coefficient are gradually decreasing, indicating that students have the highest initiative at the beginning, and the network structure is also relatively close. The more they are later, the less willing they are to participate in the discussion of the forum. Therefore, teachers should fully consider this point in the teaching process, and should set up some suitable themes to attract students in order to make the students willing to participate in the discussion of the forum. In the interactive network of 7 topic posts among them, s20 is basically in the position of the central node, indicating that the student is more active, interacts more in the forum, actively participates in the discussion of the forum, and when the teacher conducts a process evaluation, the student may be given appropriate reward points accordingly. Student3 and student19 are not very active, not fully participated in the discussions in the forum, the interaction with other students is too little or no interaction. Teachers should guide them to participate in discussions. The intermediate nodes of the seven topics are basically different, and the "intermediary" has been changing all the time, which shows that the overall interaction between students is relatively active, and the atmosphere of information communication and exchange is great.

As shown in Fig. 3, with the passage of time, the network density and clustering coefficient show a tendency of decreasing first and then rising, so learners communicate more closely at the beginning of term and in the middle of term. At the beginning of the semester, it may be that the teacher clearly states that the forum communication will be a part of the course achievement. Therefore, the learners communicate more actively and form a network structure with questions and answers. However, with the passage of time, the enthusiasm of learners to participate in the forum exchange activities

Table 2. Comparative analysis of network structure characteristic coefficients of different

Theme	Network density	Clustering coefficient	Central node	Edge node	Intermediate node
0926	0.3098	0.611	13, 5, 9, 20	3, 22, 6, 1	13
1017	0.2953	0.480	2, 14, 18, 19	8, 22, 12, 15	18
1107	0.2554	0.561	20, 5, 21, 14	3, 15, 22, 19	21
1114	0.3859	0.709	7, 20, 13, 18	12, 14, 22, 19	7
1128	0.1902	0.453	20, 5, 7, 17	14, 2, 6, 19	15
1205	0.2264	0.557	20, 6, 17, 7	10, 5, 19, 13	20
1212	0.1395	0.520	13, 20, 7, 1	6, 11, 10, 15, 17	20

gradually declined. The teacher reminded learners to participate actively in the forum during the semester, so in the middle of the semester, there is a rising trend again. At the end of the semester, there is less communication among learners, which may relate to the type of topic set by the teacher.

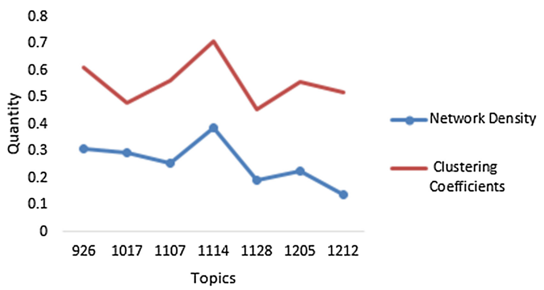

Fig. 3. Network density and clustering coefficients for different topics

4.1.2 Analysis of the Time Sequence Change of the Number of Posts Posted by the Actors

According to the statistics of the number of posts posted by the actors in Excel, the time sequence of the number of posts posted by different actors during the whole semester was plotted, and one of the three types of actors was selected for analysis by the time interval of seven theme posts. The actors selected are based on the one closest to the average number of posts in the corresponding category, as shown in Fig. 4.

In the online learning space, the number of posts, replies and views reflected the learners' enthusiasm to some extent [18]. Figure 4 shows that the number of posts posted by the three types of actors has a downward trend throughout the semester, which may have a great relationship with the theme set by the teacher. According to the analysis of the theme, it is found that the theme set above is mainly an overview of partial theory. After the theme bias to practice, resulting in learners in the practice of the theme post under the number of posts reduced. The inspiration to the subject setter

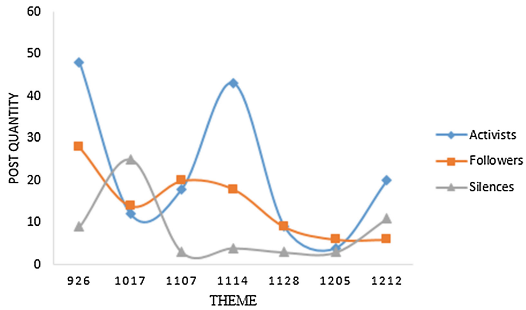

Fig. 4. Temporal change chart of the number of posts posted by three categories of actors

is that the learner should be encouraged to discuss the topic as much as possible, and the learner should be able to speak freely in a good discussion environment. As can be seen from above, the active person is very active both at the beginning and in the middle of the semester. According to the analysis, in the middle of the semester, the teacher intervened the learners, reminded the learners to participate in the forum discussion as much as possible in the face-to-face classroom, and the posting will be an important module for the evaluation of the end of the semester.

4.2 Implicit Behavior Analysis

Implicit behavior corresponds to explicit behavior and is also a term in behaviorist psychology. Implicit behavior is also called internal behavior, which includes various psychological processes such as perception, memory, thought, emotion, will and so on. It is a dynamic reflection of the objective environment of an individual (including explicit behavior and activity) and influences the external behavior at the same time [19]. Therefore, thinking is also an implicit behavior of individuals. In curriculum forums, learners express their thoughts through words, and implicit behaviors externalize through words.

According to the affective events theory (AET) and the relationship between emotion, cognition and behavior [20], online learners will get different emotional experiences because of the operation of network platform and the utilization of curriculum resources. The diffuse academic emotion will form the unique learning psychological environment in the specific period of the individual, and then affect the individual's learning behavior performance [21]. This study uses affective analysis tools to analyze the content of the posted text in the forum to explore the learners' emotional changes throughout the semester. Explore the correlation between positive and negative emotions of different types of actors in forums and their academic achievement.

Figure 5 shows that the emotions of the silent people were positive throughout the semester, although they were less involved in the forums, but the emotions were all positive, while the active people had negative emotions throughout the semester. Although there are many interactions in the forum, there are some negative emotions, which indicates that there is a tendency for such actors to pour out their dissatisfaction in the forum.

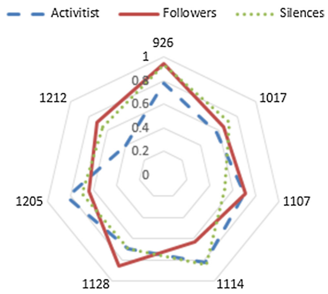

Fig. 5. Emotional evolution diagram of the three types of actors

4.3 Analysis of the Difference Between Different Actors and Learning Outcomes

According to Table 3 ($p > 0.05$), there is no significant difference between the three types of actors and their academic achievement, that is, the number of posts posted by students in the forum will not affect the students' course achievement. In the forum, since the teacher asked each student to participate actively in the discussion at the beginning of the term, there may be lots of students who just want to cope with the teacher's request and think that as long as the number of students is large, they can obtain more points. As a result, many posts are useless or irrigated, which is of no benefit to the improvement of their cognitive level, so the number of posts will not affect the learners' academic performance.

Table 3. Anova results of behavior types and learning achievement

LSD multiple comparison						
Dependent variable: results						
Type of actor (I)	Type of actor (J)	Mean difference (IJ)	Standard error	Significant	95% confidence interval	
					Lower limit	Upper limit
1	2	.238	2.791	.933	−5.58	6.06
	3	.359	2.591	.891	−5.04	5.76
2	1	−.238	2.791	.933	−6.06	5.58
	3	.121	1.896	.950	−3.83	4.08
3	1	−.359	2.591	.891	−5.76	5.04
	2	−.121	1.896	.950	−4.08	3.83

4.4 Analysis of the Correlation Between Emotions and Learning Outcomes of Different Actors

From Table 4, $p < 0.05$, indicating that the emotional coefficient is significantly related to the course performance, and the Pearson correlation coefficient = −0.442, indicating that the emotional coefficient is negatively correlated with the course performance, that is, the greater the emotional coefficient, the lower the course performance. In addition, the lower the emotional coefficient, the higher the course performance. The sentiment analysis of the text of the forum is mainly based on the frequency of the appearance of positive emotion words to determine the emotional coefficient of the text. The greater the emotion coefficient indicates that the person who posted the message expresses positive emotions, such as praise; the smaller the emotion coefficient, the most of the behaviors expressed by the posters are negative emotions, such as criticism. The behavior of expressing negative emotion should have more thought to express criticism and the question of thinking is the necessary condition for the learner to obtain the academic achievement. Therefore, this can explain the result of the analysis very well.

Table 4. Correlation analysis of affective coefficient and course achievement

Correlation			
–		Course results	Emotional coefficient
Course Achievement	Pearson correlation	1	−.442*
	Significant (bilateral)	–	.035
	N	23	23
Affective Coefficient	Pearson correlation	−.442*	1
	Significant (bilateral)	.035	–
	N	23	23

*Significantly related at the 0.05 level (bilateral).

5 Conclusion and Recommendations

Interaction is a typical and characteristic feature in online learning. Interaction quality, to some extent, relates to students' learning effect and is an important index to evaluate students' learning efficiency. Forum is the main place for online learning interaction. This paper describes the interaction characteristics of different actors in the forum. The explicit behavior and implicit behavior are analyzed and the correlation between the behavior and learning achievement is analyzed. The following conclusions are drawn: there is no significant correlation between the number of interaction of different types of actors and their course achievement; there was a significant correlation between the affective coefficients of different types of actors and their course scores. Based on the current research, this paper puts forward the following suggestions on learning strategies of hybrid classroom forums.

5.1 Increasing the Weight of Forum Interactions in the Curriculum Evaluation System

The results of the above analysis show that there is no significant correlation between the number of posts posted in the forum and the academic achievement, which is not consistent with the research conclusions of Liu Zhi and others. It can be concluded that this conclusion is related to the nature of the selected curriculum. This study selects the "educational technology research method", which belongs to the humanities curriculum, and teachers cannot avoid subjective judgment when judging the course achievement. At the same time, teachers do not conduct in-depth analysis of learners' interaction behavior in the forum, which is related to the limited energy of teachers, which is the reason for this. As a result, learners' interactive activities in the forum have less weight in the curriculum evaluation system. However, many studies have proved that forum interaction is of great significance to learners' knowledge construction. Therefore, it is suggested that teachers should increase the weight of forum interactive activities in the curriculum evaluation mechanism, encourage learners to participate actively in interactive activities, and at the same time, teachers should formulate scientific interactive activity evaluation measures. Pay attention to the evaluation of learners' learning process, can consider establishing an electronic portfolio for online learners, according to the learners' learning process to judge the course scores.

5.2 Integrating Online Interactive Activities into Instructional Design

Learning activity design is the core of instructional design. In online learning situations, learners' interaction in forums is also a learning activity. Therefore, teachers should fully design online interactive activities in instructional design, and consider which learning contents can be placed in the forum for learners to exchange and discuss, so that learners can master knowledge better. At the same time, teachers should carefully design interactive activities, integrate curriculum objectives into interactive activities, encourage learners to actively participate in forum interaction activities and inform learners that their interaction performance greatly affects their curriculum performance. The detailed interaction rules are formulated to avoid the learners from "pouring water" in the forum to influence the interactive network structure of the forum. At the same time, when designing interactive activities, teachers should analyze the characteristics of learners, take full account of the negative emotions that may occur in the process of interaction, and conduct one-to-one emotional counseling.

5.3 Online and Offline Integration, Teachers Actively Participate in Interactive Activities

Some studies have shown that the behavior of teachers in the forum is an important factor affecting the individual and group knowledge construction of learners. The number of teachers' posts, the number of responses to the topic, both the number of depth questions and the ratio of deep posts are positively correlated with the proportion of learners' high-level knowledge construction. Therefore, in the hybrid class, it is recommended that teachers attach great importance to the online discussion of learners, and actively participate in the discussion of learners, answer the learner's confusion in time, and make more posts that can arouse learners thinking. At the same time, collect the learners' learning doubts published in the forum, focus on answering the students' questions in the face-to-face classroom. Only by combining online and offline learning activities, can we give full play to the advantages of blended teaching and promote meaningful knowledge construction for learners and individuals.

This paper analyzes the text data generated in the hybrid classroom online forum, clusters learners through their interaction characteristics, and analyzes the correlation between explicit and implicit behaviors of different actors and their learning achievement. The learning strategy of blended class online forum learning is put forward. However, there are still some limitations in this study, the amount of data is not enough, and the analysis of the specific content of interactive text is lacking, which will be strengthened in the next step.

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A Study on the University Students' Use of Open Educational Resources for Learning Purposes

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Abstract. It is undeniable that open educational resources or OER have been widely used by university students for learning purposes. Over a decade, OER have been gradually evolved in different forms, including open courseware and materials, open online courses and tutorials, open e-books and e-journals, and open-source learning tools. This paper investigates the university students' use of OER for different learning purposes such as supplementing course textbooks, doing assignments and projects, and preparing tests and examinations, based on an online survey conducted to the full-time students of the Open University of Hong Kong in 2016–17, 2017–18 and 2018–19. It is revealed that the majority of students very often or often use OER for learning purposes, and more students consider OER very useful or useful for supplementing course textbooks and doing assignment and projects than for preparing tests and examinations. Among other cateogries of OER, open courseware, open course materials, open e-books, and online dictionaries are generally considered as to be very useful or useful. On the other hand, from the students' viewpoints, the accuracy and comprehensiveness of OER contents are the major concerns in using OER for learning purposes.

Keywords: Open educational resources · Open courseware · Open online courses · Open e-books · Learning effectiveness

1 Introduction

In the past decade, with the increasing internet penetration, growing popularity of digital materials, and evolving open access culture, vast amount of online resources have been openly available through the internet. According to a recent survey, 2.5 quintillion bytes of data are created in the internet per day [1]. Some of these open access resources are of educational nature, and are called open educational resources or OER. In a variety of forms, such as e-books, courseware, course materials, online courses, online dictionaries, and open source learning tools, OER are openly available through the internet for learning purposes. According to the Organization for Economic Cooperation and Development, OER is defined as the "digitized materials offered freely and openly for educators, students, and self-learners to use and re-use for teaching, learning and research" [2].

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It is undeniable that OER have been widely accepted as main sources of learning resources at almost all educational levels, from primary and secondary education to higher education. Like other online resources in the internet, OER contents have been expanding at a compound rate for many reasons. First, with the broad internet penetration, it is very convenient to share and access digital resources through the internet. This enables the openness, public availability and accessibility of OER. Second, the prevalence of digital culture enables the adoption of e-learning as to complement to the traditional learning [3–5]. Teachers and students have become accustomed to the use of digital learning resources in the teaching and learning process. Third, the open-source or open-access culture has been well developed, especially after the establishment of standard open licensing options, such as the Creative Commons [6, 7]. This provides a legitimate means to resolving the licensing and copyright issues, for one to access, share, adapt and adopt OER. Fourth, official policies and guidelines as well as good practices on the adoption of OER have been established at both the government and institution levels [8, 9].

Although OER for primary and secondary education have been well available such as open access textbooks [10, 11], the majority of OER aims for higher education. OER for higher education can be generally categorized as open courseware and course materials, open online courses and tutorials, open e-books and e-journals, and open-source learning tools [12]. Open courseware are the self-contained learning materials, organized and structured for a course of study. They are typically used for self-learning and distance learning, but can also be used in the traditional classroom environment. Examples are OpenCourseWare [13] and OpenLearn [14]. Open online courses are online courses that are openly and freely delivered through the Internet. They include massive open online courses or MOOCs, mini online courses or boutique online courses, and online tutorials, etc. Some online interactions between the teachers and students are allowed. Examples are EdX [15] and Coursera [16]. Open e-books cover open access textbooks and reference books. Some of them are also downloadable for offline usage. Examples are OpenStar CNX [17] and College Open Textbooks Collaborative [18]. Open-source learning tools broadly cover online learning platforms, online dictionaries and tools that support learning. Examples are Wikipedia [19] and Wiktionary [20].

The author conducted a study on the distance-learning students' perception on the usefulness of OER for learning purposes in 2017 [21], and another study to compare the perceived usefulness of OER between full-time and distance-learning students in 2018 [22]. This paper continue to investigate the same topic but only on the full-time students. The aim is to identify the typical use of OER by university students for learning purposes with a focus on the frequency of usage, the perceived usefulness and shortcomings. This study is based on an online survey conducted to the full-time students of the Open University of Hong Kong over the past three academic years, namely, 2016-17, 2017–18 and 2018–19. The collected data are then consolidated and analyzed in order to derive some general findings on the university students' use of OER for learning purposes.

The rest of this paper is organized as follows. Section 2 describes the design of the above-mentioned online survey. Section 3 shows the survey results, and highlights the key findings. Section 4 concludes this paper with some discussion.

2 Survey on the Use of OER for Learning Purposes

In order to study the students' use of OER for learning purposes, since the academic year 2016–17, a regular online survey on the use of OER has been conducted at the Open University of Hong Kong. The Open University of Hong Kong was established by the Hong Kong Government in 1989 to offer undergraduate and postgraduate programmes in two different modes, full-time learning and distance-learning [23]. The programmes cover subjects in various disciplines, including arts, social sciences, business administration, education, nursing, health studies, science and technology. At present, there are about 10,000 and 9,000 students, studying in full-time learning and distance-learning modes respectively. On an annual basis, the online survey has been separately conducted to the full-time and distance-learning students, usually near the end of the first semester (around early December).

Questions in the online survey are structured in three parts. Students are asked on their use of OER for learning purposes whilst the use of internet resources for non-learning purposes is excluded. The first part is more on the general usage and perception of OER for learning purposes. Students are asked on how often of using OER for learning purposes, and how useful of using OER for different learning purposes. The second part focus on the perceived usefulness of OER by the four categories, namely, open courseware and course materials, open online courses and tutorials, open access books and journals, and open source learning software and tools. Students are asked on the usefulness of the OER under each of these four categories. In the third part, students are asked on their concerns about the shortcomings of using OER, such as on accuracy, up-to-date, comprehensiveness, and organization and completeness of the contents.

The scope of study is on the use of OER by the full-time students, regardless of their years of study. Only the valid responses from the full-time students are used for analysis although responses from both full-time and distance-learning students are collected in the survey. For 2016/17 survey conducted in December 2016, a total of 215 responses from full-time students were received. The 2017/18 survey was conducted in December 2017, where a total of 356 responses from full-time students were received. In December 2018, the 2018/19 survey was conducted. A total of 414 valid responses from full-time students were received.

3 Survey Results and Key Findings

This section reports the consolidated survey results, and discuss the key findings from the survey results.

3.1 General Usage and Perception of OER for Learning Purposes

Table 1 shows how often of using OER for learning purposes. Over 80% of the respondents who very often or often access OER.

Table 1. Frequency of using OER for learning purposes.

Frequency	Years*		
	2016–17	2017–18	2018–19
Very often (every day)	39%	31%	37%
Often (more than once per week, but not every day)	43%	52%	50%
Sometimes (once per week)	14%	13%	10%
Seldom (less than once per week)	4%	4%	3%

*$N_{2016\text{–}17} = 215$, $N_{2017\text{–}18} = 357$, and $N_{2018\text{–}19} = 414$.

Table 2 shows the students' perceived usefulness of OER in supplementing course textbooks and materials, acquiring more knowledge as learning reference, getting resources for doing assignments and projects, and getting resources for preparing tests and examinations.

Table 2. Usefulness of OER for different learning purposes.

Learning purposes	Years*	Very useful	Useful	Neutral	Less useful	Not useful
To supplement course textbooks and materials	2016–17	40%	36%	22%	2%	0%
	2017–18	40%	34%	19%	4%	2%
	2018–19	37%	40%	18%	4%	1%
To acquire more knowledge as learning reference	2016–17	32%	39%	22%	4%	2%
	2017–18	35%	31%	22%	7%	5%
	2018–19	32%	37%	21%	8%	3%
To get resources for doing assignments and projects	2016–17	40%	36%	18%	4%	1%
	2017–18	43%	31%	17%	6%	2%
	2018–19	36%	38%	19%	5%	3%
To get resources for preparing tests and examination	2016–17	25%	26%	25%	15%	8%
	2017–18	29%	26%	26%	11%	7%
	2018–19	25%	33%	26%	10%	5%

*$N_{2016\text{–}17} = 215$, $N_{2017\text{–}18} = 357$, and $N_{2018\text{–}19} = 414$.

From Table 2, over 70% of respondents consider OER very useful or useful for being used to supplement course textbooks and materials, and to get resources for doing assignment and projects. Relatively less % of respondents consider OER very useful or useful for being used to acquire more knowledge as learning reference, and to get resources for preparing tests and examinations.

3.2 Usefulness of Different Categories of OER for Learning Purposes

The students' perceived usefulness of 4 different categories of OER (namely, open courseware and course materials, open online courses and tutorials, open e-books and e-journals, and open-source learning software and tools) are reported.

Table 3 shows the students' perceived usefulness of open courseware and course materials, where all types of open courseware and course materials are considered as very useful and useful by the majority, i.e. over 70% of respondents. Around 80% of respondents consider the complete sets of course materials, openly shared lecture notes and class notes very useful or useful. Relatively less % of respondents consider the openly shared video clips of lectures and classes, and other online materials very useful or useful.

Table 3. Usefulness of different types of open courseware and course materials.

Type	Years*	Very useful	Useful	Neutral	Less useful	Not useful
Openly shared complete sets of course materials	2016–17	47%	31%	18%	2%	1%
	2017–18	52%	25%	18%	3%	1%
	2018–19	43%	31%	18%	4%	3%
Openly shared lecture notes and class notes	2016–17	50%	32%	14%	2%	2%
	2017–18	52%	27%	17%	2%	3%
	2018–19	43%	36%	15%	4%	2%
Openly shared video clips of lectures and classes	2016–17	40%	24%	21%	2%	2%
	2017–18	48%	24%	21%	3%	3%
	2018–19	40%	30%	18%	7%	4%
Other supplementary online learning materials	2016–17	39%	36%	20%	4%	1%
	2017–18	43%	31%	19%	5%	3%
	2018–19	35%	36%	19%	6%	3%

*$N_{2016\text{–}17} = 215$, $N_{2017\text{–}18} = 357$, and $N_{2018\text{–}19} = 414$.

Table 4 shows the students' perceived usefulness of open online courses, tutorials and forums. Around 60% of respondents consider open online self-contained courses and online tutorials very useful or useful, whilst around 40% of respondents consider small-scale mobile learning courses, and online interactive help desk and forum very useful or useful.

Table 5 shows the students' perceived usefulness of open access books, journals and other documentation. Over 70% of respondents consider open access textbooks and reference books very useful or useful. Relatively less % of respondents consider open access journals, magazines and periodicals, and other online documentation very useful and useful.

Table 6 shows the students' perceived usefulness of open source learning software and tools. Around 65% to 75% of respondents consider the open online dictionaries, encyclopedia, anti-plagiarism checker and grammar checker very useful or useful. Relatively less respondents (around 60%) consider online learning software, learning platform for self and collaborative learning.

Table 4. Usefulness of different types of open online courses, tutorials and forums.

Type	Years*	Very useful	Useful	Neutral	Less useful	Not useful
Open online courses and self-contained courses	2016–17	27%	34%	30%	7%	3%
	2017–18	32%	27%	28%	9%	5%
	2018–19	31%	29%	26%	10%	4%
Open online tutorials on specific topics	2016–17	20%	36%	33%	7%	4%
	2017–18	28%	30%	31%	8%	3%
	2018–19	25%	31%	30%	10%	5%
Small-scale mobile learning courses and applications	2016–17	16%	21%	42%	16%	6%
	2017–18	18%	21%	40%	12%	9%
	2018–19	18%	23%	36%	14%	9%
Open online interactive help desks, and forums	2016–17	16%	23%	31%	18%	13%
	2017–18	17%	21%	32%	19%	12%
	2018–19	20%	22%	32%	16%	10%

*$N_{2016\text{–}17} = 215$, $N_{2017\text{–}18} = 357$, and $N_{2018\text{–}19} = 414$.

Table 5. Usefulness of different types of open access books, journals and other documentation.

Type	Years*	Very useful	Useful	Neutral	Less useful	Not useful
Open access e-books (self-contained textbooks)	2016–17	61%	20%	12%	2%	4%
	2017–18	56%	23%	14%	5%	2%
	2018–19	42%	28%	19%	5%	5%
Open access e-books (self-contained reference books)	2016–17	52%	25%	16%	3%	4%
	2017–18	52%	24%	16%	6%	2%
	2018–19	37%	31%	20%	6%	5%
Open access journals, magazines and periodicals	2016–17	35%	25%	26%	10%	4%
	2017–18	36%	20%	24%	13%	4%
	2018–19	28%	25%	30%	10%	8%
Open access reports and other documentation	2016–17	45%	29%	17%	7%	2%
	2017–18	43%	26%	20%	9%	3%
	2018–19	34%	29%	25%	8%	5%

*$N_{2016\text{–}17} = 215$, $N_{2017\text{–}18} = 357$, and $N_{2018\text{–}19} = 414$.

3.3 Shortcomings or Concerns of OER for Learning Purposes

Despite many advantages, like many open online resources, OER also have their own shortcomings. The quality, accuracy, readability, completeness, comprehensiveness and relevancy of the contents are of some well-known concerns of using OER for learning purposes [24, 25].

Table 6. Usefulness of different types of open source learning software and tools.

Type	Years*	Very useful	Useful	Neutral	Less useful	Not useful
Open online dictionaries and encyclopedia	2016–17	43%	33%	21%	1%	1%
	2017–18	43%	26%	23%	5%	3%
	2018–19	40%	32%	18%	5%	4%
Online anti-plagiarism checker and grammar checker	2016–17	40%	33%	20%	5%	3%
	2017–18	37%	28%	22%	8%	6%
	2018–19	41%	27%	20%	8%	5%
Online learning software (mind-map, slide-builder, etc.)	2016–17	30%	34%	25%	7%	3%
	2017–18	28%	32%	24%	11%	4%
	2018–19	38%	28%	20%	10%	4%
Online learning platform for self and collaborative learning	2016–17	27%	33%	27%	9%	4%
	2017–18	27%	30%	30%	10%	3%
	2018–19	34%	28%	25%	8%	4%

*$N_{2016\text{–}17} = 215$, $N_{2017\text{–}18} = 357$, and $N_{2018\text{–}19} = 414$.

Table 7 shows the students' concerns about using OER, such as on the accuracy, up-to-date, and comprehensiveness. Around 60% of respondents strongly agree or agree that OER contents may not be accurate. Around 50% of respondents strongly agree or agree that OER contents may not be comprehensive. Relatively less respondents (less than 50%) strongly agree or agree that OER contents may not be up-to-date nor well organized.

On the other hand, around 15% of respondents strongly disagree or disagree that OER contents may not be accurate nor comprehensive. Relatively more respondents

Table 7. Shortcoming of using OER for learning purposes.

Shortcoming	Years*	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Contents may not be accurate	2016–17	17%	41%	28%	13%	1%
	2017–18	24%	37%	25%	11%	3%
	2018–19	20%	35%	30%	11%	4%
Contents may not be up-to-date	2016–17	9%	36%	31%	21%	3%
	2017–18	17%	29%	33%	15%	7%
	2018–19	11%	29%	36%	17%	6%
Contents may not be comprehensive	2016–17	18%	35%	31%	13%	3%
	2017–18	19%	37%	28%	11%	4%
	2018–19	16%	33%	32%	13%	5%
Contents may not be well organized	2016–17	13%	28%	37%	18%	4%
	2017–18	17%	30%	35%	12%	5%
	2018–19	15%	23%	38%	20%	5%

*$N_{2016\text{–}17} = 215$, $N_{2017\text{–}18} = 357$, and $N_{2018\text{–}19} = 414$.

(17% to 24%) strongly disagree or disagree that OER contents may not be up-to-date nor well organized. There is also an interesting observation that quite a significant portion of respondents (25% to 38%) do not have strong concerns (stated as neutral) on the shortcomings of OER.

3.4 Summary of Key Findings Form the Survey Results

The survey results are summarized, and the key findings are identified as follows.

- In general, OER are very often or often used by the majority of students for various learning purposes.
- OER are generally considered to be very useful or useful for being used to supplement course textbooks and materials, acquire more knowledge as other learning reference, and get resources for doing assignments and projects.
- The majority of students consider open courseware and course materials very useful or useful. Complete and self-contained course materials, lecture notes and class notes are more preferred than video clips of lectures and classes.
- The majority of students consider open online courses and tutorials very useful or useful, whilst less than half consider small-scale mobile learning courses and online interactive help desk and forum very useful or useful.
- Self-contained open textbooks and reference books (but not journals) are considered to be very useful or useful by the majority of students.
- Open online dictionaries, encyclopedia, antiplagiarism and grammar checker are considered to be very useful or useful by the majority of students.
- Students are more concerned about the accuracy and comprehensiveness than the up-to-date and organization of the OER contents.

4 Conclusion

OER have been widely recognized as a major source of learning resources, especially in higher education. For two decades, like many other Internet resources, vast amount of OER have been developed in various forms, ranging from open courseware, open online courses and tutorials to open e-books, e-journal and open learning tools. In order to understand the students' usage and perceived usefulness of OER for learning purposes, in the past 3 years, an annual online survey has been conducted to the full-time students at the Open University of Hong Kong. This paper reports the survey results, and attempts to consolidate the data and conduct analysis. A number of key findings are highlighted.

There are no significant variations on the survey results across the past 3 years, implying that the students' usage patterns and perceived usefulness of OER have become more stable. Based on the commonalities found from the survey results, the typical use of OER by university students can be identified. It is revealed that OER are generally considered useful, especially as being used to supplement course textbooks and to get resources for doing assignments and projects. Among others, open courseware and course materials, online courses, open e-books, and online dictionaries or encyclopedia are we adopted for learning purposes. The accuracy and comprehensiveness of OER contents are major concerns of the majority of students. It is also observed that there are no significant variations on the data over the past three years. All these findings can help provide some useful reference in the adoption of OER in higher education.

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Syllabus Design for Teacher Education MOOCs (Massive Open Online Courses): A Mixed Methods Approach

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Abstract. Massive Open Online Courses (MOOCs) have been used increasingly in education. The selection and grading of course content, i.e. the syllabus, constitutes the basis for MOOC development. However, less attention has been paid to the construction of a syllabus from an empirical perspective which this study addresses by designing a syllabus for MOOC, aiming at improving English teachers' assessment competencies, i.e. assessment literacy. Applying a mixed methods research approach, we firstly administered an open-ended questionnaire to 468 English teachers of Chinese schools to brainstorm initial components of an assessment literacy inventory (ALI). We then surveyed 318 English teachers with a structured questionnaire. With exploratory factor analysis, we extracted six components for the ALI, i.e. basic knowledge, formative assessment, administration and use of results, use of IT, task construction, and doing research, on the basis of which we proposed a syllabus. Lastly, we interviewed five experts to validate the proposed syllabus.

Keywords: MOOC syllabus design · Assessment literacy · Teacher education · Factor analysis

1 Introduction

In recent years, the Chinese Ministry of Education has clearly put forward the "Internet plus(+) Teacher Education" Action Plan, pointing out the necessity of making full use of new technology such as MOOCs in teacher education. As a response, a growing number of studies focusing on MOOCs have been carried out. The main topics discussed in the literature include MOOCs' influence in education (e.g. De Freitas et al. 2015), student behavior and learning outcomes (e.g. Park et al. 2015), and course evaluation (e.g. Margaryan et al. 2015). However, there have been few empirical studies of MOOC syllabus design, which constitutes the basis for MOOC development. In current practice, MOOCs content is generally designed by reference to the syllabuses of relevant offline courses, teachers' previous experience or through some other unknown ways.

There are some differences in syllabus design between a traditional course and a MOOC. The traditional course is limited in the time and place of teaching, and the number of students. Its syllabus is pre-designed, systemic and more comprehensive.

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However, a MOOC is open to all the students and teachers as long as they can access internet. Its syllabus needs to be designed to focus on important and key issues in teaching, and to adapt students of various knowledge levels. The syllabus of MOOC is problem-driven, so the teachers' feedbacks are necessary in the design process. From an empirical perspective the lack of syllabus design might negatively influence the MOOC content regarding its systematic, effective and unique nature, which motivated us to carry out evidence-based research into the syllabus design of our MOOC aimed at developing Chinese English teachers' assessment literacy. The present study attempts to provide insight into MOOC construction methodology, especially how a course syllabus is designed using both quantitative and qualitative methods.

2 Literature Review

2.1 MOOCs

In 2008, the term MOOC was coined by George Siemens and David Comier to describe Connectivism and Connective Knowledge, a free online course delivered to thousands of students (Ebben and Murphy 2014), which is the mixed product of education and technology. Since then MOOCs have been widely used in higher education around the world. In 2012, some platforms were set up in the USA, including Udacity, Coursera, EdX. In China, universities such as Peking University and Tsinghua University have also begun to seek cooperation with international established MOOC platforms. The Chinese MOOCs platforms were developed jointly by local enterprises and universities, such as XuetangX, NetEase Cloud classroom and Chaoxing MOOCs. For example, "The Chinese University MOOCs", a network of universities employing MOOCs co-founded by the Chinese Ministry of Education and NetEase in 2014, includes 289 universities and has attracted millions of learners till January 2019. This rapid expansion of MOOCs is attributed to their fundamental characteristics of being open, participatory and distributed (Baturay 2015).

To date, studies of MOOCs fall into three groups. One group examines the advantages and challenges of MOOCs. Charging no registration fees, having an open curriculum, and having flexible outcome requirements (Zhu et al. 2018), MOOCs attract students with high motivation (Hew and Cheung 2014). However, MOOCs also face some challenges, such as difficulty in evaluating students' work, lack of immediate feedback on students' work, being burdened by heavy demands of time and money, and lack of student participation in online forums (Hew and Cheung 2014). A second group of studies explores their participants. Researchers discussed learners' retention, perception, motivation, performance and interaction in MOOCs. For instance, Jordan (2014) investigated 279 completed courses from Coursera, EdX, and Udacity and found high dropout rates of students with only 6.5% retention. To retain the students in MOOCs, Tang et al. (2015) developed a framework to help lecturers decide on necessary actions. A third group of studies focuses on the quality of MOOCs, assessing the content of MOOCs. Margaryan et al. (2015), for example, analysed 76 MOOCs and found that most scored highly on organization and presentation of course materials, but that the quality of their instruction design was not good. Zhang et al. (2017) also reviewed 150 Chinese articles about MOOCs and made a summary of the research foci, including the discussion of MOOC concept, MOOC platform, teaching mode and design, and MOOC assessment.

Current studies offer some references for developing the syllabi of MOOCs. However, there are few empirical studies of the construction of a content selection framework for MOOCs. The following discussion will shift the focus to the theme of one particular type of MOOC, i.e. English teachers' assessment literacy.

2.2 Teacher Assessment Literacy

There is no universal agreement on the definition of assessment literacy. For example, Stiggins (1991) defined it generally as the ability to know and understand key principles of sound assessment. Derived from the general assessment literacy, language assessment literacy seeks to prescribe the distinctive assessment competencies for language teachers. Davies (2008) identified three components for language assessment literacy: skill, knowledge and principles. Davies highlighted the knowledge of language and language teaching methodologies. Fulcher (2012) pointed out that language teachers should be familiar with the standardized or classroom test (test processes and principles). Besides the knowledge base, teachers' self-awareness and interpretation in assessment also shape their practical language assessment literacy (Scarino 2013). The assessment literacy in the Chinese context was also discussed by Chinese scholars. Lin and Gao (2011) defined the language assessment literacy with the framework of "What", "Why" and "How". Tang (2013) argued that English teachers should possess multilayer knowledge and skills about general assessment and language features. But these research claims were built on western contexts, lacking empirical evidence specifically with reference to the Chinese context.

The literature also discussed teachers' levels of assessment literacy and their training needs. Mertler (2004) designed a *Classroom Assessment Literacy Inventory* and measured the literacy level of teachers in the USA, showing that both pre-service and in-service teachers felt inadequate to assess students' performances. Zheng (2010) found that Chinese teacher assessment literacy is on a lower level by investigating 954 primary and secondary school teachers in China. Jin (2010) investigated language testing and assessment courses at tertiary level in China. She found that educational and psychological measurements and student classroom practice received less attention in training courses. To improve teachers' assessment literacy, courses that train teachers in assessment are needed as the single "textbook mode" could not satisfy teachers' needs in practice. Many new training modes have emerged recently, such as workshop, distance learning, blended learning and self-access approaches (Malone 2013). Under the "Internet+Teacher Education" Action Plan, the use of the MOOC platform promises to improve teacher assessment literacy.

3 Methodology

3.1 Research Questions

The main purpose of the study is to select appropriate content for the assessment MOOC. Two research questions are formulated to achieve the objective:

(1) What key components constitute the syllabus of the assessment MOOC?
(2) To what extent is the proposed syllabus of the assessment MOOC valid?

In the present study, the syllabus refers to the selection and grading of content for the MOOC. As the MOOC aims at improving teachers' assessment literacy, an ALI, i.e., a list of assessment competencies, will therefore be considered and used to develop the syllabus. The first research question addresses the components of the syllabus. After identifying the key elements of the ALI, the key components of the MOOC syllabus can be decided and a specific content framework can be proposed. The second research question concerns the validity of the proposed syllabus, that is, how valid and reliable is the syllabus suggested.

3.2 Research Design and Methods

3.2.1 General Design and the Participants

English teachers' feedbacks play an important role in designing the syllabus of MOOC. To fully understand their opinions, this three-phase study adopted a mixed methods approach (Cohen et al. 2011), integrating a quantitative method, i.e. a questionnaire survey, with a qualitative method, i.e. an interview. The first and second phases are related to the first research question and the third phase targets the second research question.

In the first phase, an open-ended questionnaire was used to brainstorm English teachers' perceptions of ALI components and their expectations of the assessment training course. The results derived from this questionnaire contributed to the formulation of the second questionnaire. The first phase involved 468 English language teachers from Guangzhou, the capital city of Guangdong province, including 147 primary, 168 junior and 153 senior high school English teachers. All the participants were selected randomly. The responses of primary school English teachers were collected immediately after they finished the questionnaire. The other participants answered the questionnaire online, which was administered by the local education department.

In the second phase, an online questionnaire was developed to extract the ALI components through factor analysis and then to propose the syllabus. The survey was delivered via WeChat, a popular social communication platform in China. In total, 318 valid responses were collected from 31 primary English teachers, 182 junior English teachers and 105 senior high school English teachers from four cities of Guangdong.

In the third phase, five experts in English language teaching and information technology were asked to judge the appropriateness of the syllabus. Their responses provide the evidence for validating the main findings of the study.

3.2.2 Instruments

3.2.2.1 Questionnaires

A questionnaire was used as the main instrument for two reasons: one is that, it is a relatively cheap and convenient way to capture data from a wider target population, and the other is that it can be used to measure and describe generalized features. In the first phase, the questionnaire was to brainstorm participants' perceptions of ALI and their expectations of the assessment training programs. Three open-ended questions were included in the first questionnaire: What knowledge and skills do you think English teachers are expected to have in order to assess students' work? To what degree have you obtained such knowledge and skills? What do you expect to learn in assessment training courses?

In the second phase, a three-part questionnaire was developed in a stepwise process. The item pool was established based on the findings derived from both the first survey and the literature about assessment literacy, with effective items written out and sequenced. After being piloted among five postgraduates who had majored in language assessment and teaching, the item descriptions were refined to be clearer and more readable. Finally, the questionnaire was divided into three parts. The first part comprised five close-ended items to elicit respondents' demographic information about gender, teaching experience, academic qualification, school level and administrative division. The second part comprised 50 items in the form of statements, investigating the teachers' perceptions of the importance of different assessment literacy competencies. Specifically, items 1–5 concerned the competence of understanding concepts and theories in assessment; items 6–10, assessment planning; items 11–18, assessment task construction; items 19–27, formative assessment; items 28–30, scoring rubric design; items 31–34, assessment result analysis; items 35–38, teacher reflection & doing assessment research; items 39–42, application of information technology; items 43–45, student & parent caring; items 46–50, assessment administration & teaching adjustment. The options took the form of a five-point Likert scale ranging from 5 ("Strongly Important") to 1 ("Unimportant"). The last part comprised one open-ended question to encourage respondents to add more information about ALI components.

3.2.2.2 Interview

In the third phase, an interview was used to collect qualitative data and five experts were invited to express how they regarded the proposed syllabus from their own point of view. Considering the interviewees were experts with rich teaching experience, an unstructured interview was employed with the aim of collecting richer data. Only one open-ended question was asked at the beginning of the interview: Do you think the proposed syllabus reflects the requirements of teaching practice and teachers' needs?

4 Results

4.1 Initial Ideas About ALI Components and Training Needs

The results of the first phase indicated the relevant knowledge that teachers of English as a Foreign Language (EFL) should have. They had some initial ideas about ALI components, including assessment functions, such as washback effects, language knowledge and competence, assessment design principles, and the reliability and validity concept related to assessment. EFL teachers' lack of knowledge is also an integral part of assessment literacy, such as the relation between assessment purpose and types, formative assessment, analysis and application of assessment results, etc. A questionnaire was designed based on the teachers' ideas and the related literature. As for teachers' training needs, the predominant need is for the design of various assessment tasks in line with National English Curriculum Standards.

4.2 Assessment Literacy Inventory

To extract the ALI components, all the data obtained in the second phase were analysed via Exploratory Factor Analysis (EFA), using SPSS 22.0. Prior to EFA, each item was tested to have significant discriminability power in the process of item analysis. The expected value of KMO (0.961) and Bartlett's test of sphericity ($\chi 2 = 10782.228$, $p < 0.001$) proved the suitability of EFA. Then Principal Components Analysis (PCA) and Varimax rotation were used to extract factors. The screen plot and the variance explained indicated six factors could be extracted, which could explain 64.95% of total variance. According to the common construct of the items in each factor, the factor names were as follows: (1) Factor 1 indicated basic knowledge of assessment; (2) Factor 2 recommended formative assessment; (3) Factor 3 indicated administration of assessment task and the use of assessment results; (4) Factor 4 indicated the use of information technology; (5) Factor 5 indicated assessment task construction; (6) Factor 6 indicated the expertise needed in doing assessment research. Table 1 details the EFA results. The six assessment literacy elements together provide the foundations for the construction of the assessment MOOC syllabus.

4.3 Assessment MOOC Syllabus

The survey findings indicated that the central concept, knowledge and skill related to assessment were the foci of the MOOC. With reference to the factor analysis results of the ALI, we designed five modules with two layers, main topics and sub-topics, for the MOOC content with the course title "*How to Assess English Learning*". The first module comprises the overview of testing and assessment, including the observable variables in factors 1, 3, 4 and 6. It discusses general assessment knowledge, such as basic assessment concept, procedures, rubrics, classification, test specification, information technology and item analysis skills. The other four modules focus on assessment of vocabulary, grammar, listening, speaking, reading and writing. The main contents of the MOOC were drawn from factors 2 and 5. These five modules were in accordance with Chinese National English Curriculum Standards, taking language

Table 1. The EFA results of assessment literacy inventory

Items	Cumulative %	Components					
		Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
6	12.61%	0.736					
2		0.711					
5		0.701					
1		0.692					
4		0.681					
3		0.672					
7		0.663					
8		0.570					
28	24.86%		0.668				
24			0.654				
21			0.651				
26			0.643				
19			0.608				
25			0.586				
27			0.547				
23			0.496				
13			0.445				
46	36.72%			0.706			
47				0.691			
48				0.687			
49				0.670			
50				0.650			
45				0.559			
43				0.550			
44				0.462			
40	48.45%				0.731		
41					0.664		
36					0.635		
42					0.627		
33					0.626		
39					0.598		
32					0.592		
9					0.534		
15	60.06%					0.739	
17						0.686	
16						0.683	
14						0.616	
18						0.589	
29						0.575	
30						0.516	
31						0.475	
22						0.403	

(*continued*)

Table 1. (*continued*)

Items	Cumulative %	Components					
		Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
35	64.95%						0.507
37							0.465
34							0.431

knowledge and language skills as carrier and simultaneously assessing students' awareness of culture, quality of thinking and learning ability. Each module had four or five main topics, delivered in the forms of document, video clip, interview, quiz and discussion, covering the essential knowledge and ability related to assessment. As Table 2 shows, topic 1 covers general assessment knowledge, such as assessment objective and assessment methods, while the other topics introduce ways of designing objective and subjective tests and performance assessment tasks. The sub-topics cover the specific assessment tasks frequently used in primary and secondary English teaching practices.

Table 2. Syllabus of assessment MOOC

Module	Main topics	Sub-topics (delivering mode)
Overview	Assessment function and methods	Teaching & assessment (I); Assessment methods (D); Assessment Literacy (D); Integrating teaching, learning & assessment (V&D)
	Assessment procedures	Assessment procedures (D); Test specification (V&D); Soring rubrics (V&D); Data analysis & writing report (D)
	Overview of pen-and-paper test	Test tasks in objective and subject testing (D); Quality evaluation of MC (V&D); Quality evaluation of Cloze (D); Quality evaluation of Filling in the gap, Q&A (V&D); Case study of pen-and-paper test (Dis)
	Overview of performance assessment	Assessment & learning (I); types of PA (D); Portfolio assessment (V&D); Project assessment (D); Task-based assessment (D); Case study of PA (Dis)

(*continued*)

Table 2. (*continued*)

Module	Main topics	Sub-topics (delivering mode)
Vocabulary and grammar assessment	Assessment goal and methods	Key competence & VG assessment (I); Assessment goal of VG (D); Assessment methods VG (D)
	Selection, modification and development of vocabulary (V) test	Features of a good VG test (I); Vocabulary MC & Matching test (V&D); Filling in the gap in V test (V&D)
	Selection, modification and development of grammar (G) test	Grammar MC (V&D); Filling in the gap in G test (V&D); Correcting errors in G test (V&D); Case study of G test (Dis)
	Performance of assessment	Self-assessment in VG (I&D); Puzzle & word web (V&D); Grammar game (V&D); PA in grammar(Dis)
	Exam construct & Teaching tips	VG assessment in ZhongKao (D); VG assessment in GaoKao (D); Test taker analysis in GaoKao (V&D); VG teaching tips & exam preparation (V&D)
Listening and speaking assessment	Assessment goal and methods	Key competence & LS assessment (I); Assessment goal of LS (D); Assessment methods of LS (D)
	Selection, modification and development of listening (L) objective test	Features of a good LS test (I); Selection of listening material (D); Listening MC (V&D); Listening matching & ordering (D)
	Selection, modification and development of listening subjective test	Filling in the table (V&D); Filling in the gap (V&D); Q&A (D); Assessing experience exchange (Dis)
	Selection, modification and development of speaking (S) test	Pronouncing, reading aloud & chanting (V&D); Describing picture, making presentation & debate (V&D)
	Performance assessment	Features of a good PA task in LS (I); Reading, retelling & role playing (D); Discussion, interview & information gap task (V&D); Self-assessment in LS
	Exam construct & Teaching tips	LS assessment in ZhongKao (D); LS assessment in GaoKao (D);Test taker analysis in GaoKao (V&D); LS teaching tips & exam preparation (V&D)

(*continued*)

Table 2. (*continued*)

Module	Main topics	Sub-topics (delivering mode)
Reading assessment	Assessment goal and methods	Key competence & R assessment (I); R Assessment goal (D); R Assessment methods (D)
	Selection, modification and development of reading (R) objective test	Features of a good R test (I); Selection of reading material (D); Reading MC (V&D); Reading matching & ordering (D)
	Selection, modification and development of reading subjective test	Filling in the table (V&D); Filling in the gap (V&D); Q&A (V&D)
	Performance assessment	Features of a good PA task in R (I); R&W/S task (V&D); Reading log & reading report (V&D); Self-assessment in R
	Exam construct & Teaching tips	R assessment in ZhongKao (D); R assessment in GaoKao (D); Test taker analysis in GaoKao (V&D); R teaching tips & exam preparation (V&D)
Writing assessment	Assessment goal and methods	Key competence & W assessment (I); W Assessment goal (D); W Assessment methods (D)
	Selection, modification and development of writing (W) test	Features of a good W task (V); Testing & assessment in W (V&D); Guided writing (D); Sentence formation (V&D); Information filling (V&D); Writing letter (V&G); Writing summary (V&G)
	Performance assessment	Features of a good PA task in W (**I**&D); Pen pal activity (V&D); Creative writing (D)
	Exam construct & Teaching tips	W assessment in ZhongKao (D); W assessment in GaoKao (D); Test taker analysis in GaoKao (V&D); W teaching tips & exam preparation (V&D)

Abbreviations in delivering modes: I = Interview; D = Document; Dis = Discussion; V = Video clip
Abbreviations in language knowledge & skills: V = Vocabulary; G = Grammar; L = Listening; S = Speaking; R = Reading; W = Writing

4.4 Validity of the Proposed Syllabus

The proposed syllabus was validated by expert judgments. For example, Expert A, a professor of language testing from a local university made comments on the relationship between the syllabus and the requirements issued by the Ministry of Education:

> "The syllabus sheds light on the assessment requirement of the National Curriculum Standards. It's a good idea to introduce both formative and summative assessment in the MOOC, especially how to design a formative assessment task in classroom teaching."

Expert D, a very experienced university teacher of Educational Technology, paid special attention to the technological element included in the ALI:

> "I think this inventory is very comprehensive and it even includes the technology item. Actually automated scoring, computer-based testing are very popular now. So, it's important for teachers to understand the situation and try the new techniques."

Generally, the five experts believed that the selection and grading of the content was appropriate for English teachers in Chinese schools, and that the content design was also appropriate for a training course delivered on line.

5 Discussion and Conclusion

Overall, the results from the study indicate that there are six components of ALI in the Chinese EFL context, i.e. basic knowledge of assessment, formative assessment, administration of assessment task and the use of assessment results, assessment task construction, use of information technology in assessment, and expertise in doing assessment research. The first four components are not surprising and our findings confirm the claims made by some other assessment literacy researchers, e.g. Davies (2008); Fulcher (2012); Lin and Gao (2011); Mertler (2004) and Scarino (2013). As language teachers, they are expected to understand some essential concepts and methodology in assessment such as the functions and methods of assessment, procedures of designing assessment task, how to develop test specifications in order to assess their students' progress. It is interesting to find that information technology and expertise in doing research are also included in the ALI, which is new to the field of ALI research. With the development of information technology in education, more and more techniques are introduced to the language assessment area, such as automated scoring in writing tests, and natural language processing in speaking tests. Information technology is extremely necessary and important in China with its large population of test takers. English teachers face new challenges in coping with their professional development and it is no wonder that they believe IT knowledge should be an ALI component. There is another important component that is relevant to assessment research. It is commonly believed that doing research has nothing to do with doing assessment practice in teaching; however, the present study indicates that this is not the case. Teachers' understanding of research methods such as how to analyse test items helps with the construction of the item pool in preparing a test.

The evidence-based five-module two-layer course syllabus is designed systematically and is unique in nature. It follows a top-down approach and includes a series of topics from general to specific in the area of assessment. It also reflects current EFL teaching practice in the Chinese context, covering assessment of language knowledge (i.e. vocabulary and grammar) and language skills. In addition, the syllabus is specially designed for an assessment MOOC and it is unique in three ways, compared to traditional offline assessment training courses. First, informativeness. The syllabus contains a very comprehensive list of assessment topics at schools and the course can offer a huge amount of resources in different modes for learners. Second, flexibility. Our MOOC is offered online and regardless of their educational and teaching background, everyone can be a course participant. For example, one main topic is classified into three sub-topics to cater for differences between teachers from schools at different levels. As for the main topic "formative assessment task design" in the module of Listening and Speaking, there are three sub-topics: "chanting in primary school", "story-telling in junior high school" and "debate in senior high school". Last, methodology. Concerning the advantages of MOOC, topics are introduced via different modes, e.g. document, video clip and discussion. The selection of mode is decided by the importance of the topic, the teacher's familiarity with the topic and the learning styles in English teacher education.

The assessment MOOC based on the syllabus discussed in this paper has been put into use since April 2018 on a national MOOC platform in China. So far comments from participants have generally been positive and the content of the course is regarded as scientific, systematic and operable. On the other hand, it has to be admitted that there are some limitations such as the lack of teachers' own reflections on assessment practice in the topic list.

To sum up, some implications can be drawn from the present study for MOOC developers and teacher educators. Quantitative methods such as factor analysis can assist in constructing a syllabus. MOOC is a promising way to improve the effectiveness of teacher training. Generally, course content construction can be a dynamic process, allowing for constant modification and improvement with feedback from the learners. Therefore, empirical studies of continuous syllabus refinement with more precise feedback data analysis should be conducted in future.

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Empirical Investigation of E-learning Adoption of University Teachers: A PLS-SEM Approach

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Abstract. Nowadays, information technology has a revolutionary impact on virtually all aspects of education. New horizons for learning, teaching and educational administration have been opened up by its transformation. Teachers must effectively master the available technology to excel in education. The aim of this research is to examine the acceptance of information technology of university teachers and identify their influencing factors. Valid data was collected over 500 university teachers and analyzed using the UTAUT 2 model. The result of PLS-SEM analysis indicates that the Performance Expectancy, Facilitating Conditions, Hedonic Motivation, and Habit significantly influence the university teachers' Behavioral Intention of E-learning. Content of the courses has moderating effect of Performance Expectancy and Facilitating Conditions on the university teachers' Behavioral Intention when pursuing further education. This study recommends the continuing education providers focus more on the core value of the contents to gain a competitive edge in the continuing education market sector and teachers should identify ways of optimizing technology.

Keywords: E-learning · University teachers · UTAUT 2 model

1 Introduction

In the new era, one of the breakthroughs in the higher education reform is to put information-based innovative education in an important position and give priority to its consideration. University teachers need to integrate modern information technology to lead the education innovation. The number of university teachers using E-learning to pursue further education such as professional skills or certificate acquisition has been increased. To promote the participation in E-learning, this study investigates the factors that have significant influences toward E-learning. Eight constructs in the Unified Theory of Acceptance and Use of Technology 2 model will be examined, including Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, Habit and Behavioral Intention. Furthermore, it also tests the moderating effect of Contents of E-learning.

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2 The UTAUT 2 Theory

The continuance use of a new technology is subject to different reasons. Technology Acceptance Model by Davis (1989), Diffusion of Innovation by Rogers (1995) and The Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003) all explored to explain the user adoption of a technology. In the UTAUT theory, Venkatesh et al., integrated eight different theories and suggested four determinants accounted for the use of a new technology. These factors are: Performance Expectancy, Effort Expectancy, Social Influences and Facilitating Conditions. The description is listed as followed. PE is how much the user believes a technology would enhance his job performance. EE is the effort the user thinks he needs to take when using a technology. SI is the degree the user perceives that relevant people prefer he uses the technology. FC is the support of an organizational and technical infrastructure. Meanwhile, four key moderators such as age, gender, experience, and voluntariness of use are also investigated. The UTAUT describes the adoption of a technology in an organization. Lately, Venkatesh et al. (2012) expanded UTAUT to UTAUT2 by adding three more variables: Hedonic Motivation, Price Value, and Habit. HM means the enjoyment of using a technology. PV refers to the price value of this technology. HB is defined as the habit having direct or indirect effect. The UTAUT2 model explains the determinants of the individual acceptance of a new technology. Regarding to this study, the UTAUT2 model will be applied to explain the influencing factors that significantly affects the adoption of E-learning of university teachers.

3 Research Hypothesis

Under UTAUT2 model, PE, EE, SI, FC, HM, PV, and HB possibly have significant effects on BI toward E-learning of university teachers; and differences in the contents of E-learning (CT) may have moderating effects of PE, EE, SI, FC, MH, PV, and HB on BI. The hypotheses below were developed. Figure 1 presents the research model.

An online survey was conducted. Invitation letters were sent to individual university teachers to answer the questionnaire through E-mails, WeChat forums and QQ groups. There are 591 respondents submitted their questionnaires in January 2019, 72 sets of invalid data were deleted and the sample size was ultimately 519.

H1: Performance expectancy (PE) has a direct effect on Behavioral Intention (BI)
H2: Effort expectancy (EE) has a direct effect on Behavioral Intention (BI)
H3: Social Influence (SI) has a direct effect on Behavioral Intention (BI)
H4: Facilitating Conditions (FC) has a direct effect on Behavioral Intention (BI)
H5: Hedonic Motivation (HM) has a direct effect on Behavioral Intention (BI)
H6: Price Value (PV) has a direct effect on Behavioral Intention (BI)
H7: Habit(HB) has a direct effect on Behavioral Intention (BI)
H8: Contents (CT) has moderating effects of PE, EE, SI, FC, HM, PV, HB.

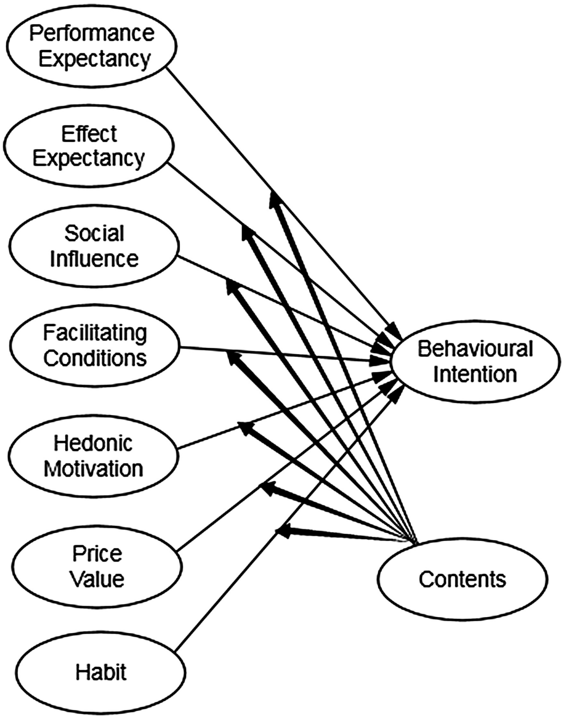

Fig. 1. Research model

4 Findings

4.1 Sample Characteristics

From the online surveys in January 2019, 519 sets of valid data were collected from university teachers. The measurable items for eight constructs were adopted from UTAUT2 (Venkatesh et al. 2012). The sample characteristics are listed in Table 1. The percentages of male and female respondents are 48.17% and 51.83% respectively. Most of the respondents were belonged to young generation aged between the range of 35–39 (26.59%), 30–34 (18.3%) and 25–29 (12.91%). Nearly half of university teachers held a Master degree (48.17%). And teachers came from public universities took up to 92.49%.

4.2 Reliability and Construct Validity

Means, standard deviations, excess kurtosis and skewness of each measurement item were demonstrated in Table 2. The values of PLS loadings of each construct exceed 0.7, meaning the data reached the recommended level.

Table 1. Demographic information (n = 519)

		Frequency	Percentage
Gender	Male	250	48.17
	Female	269	51.83
Identity	University leaders	3	0.58
	Middle-level cadres	66	12.72
	Teaching management personnel	35	6.74
	Ordinary teacher	344	66.28
	Assistant	21	4.05
	Others	50	9.63
Age	25–29	67	12.91
	30–34	95	18.3
	35–39	138	26.59
	40–44	109	21
	45–49	50	9.63
	50–54	40	7.71
	55–59	15	2.89
	60–65	3	0.58
	Over 65	2	0.39
Education degree	Bachelor	124	23.89
	Master	250	48.17
	PhD	132	25.43
	Post-Doctoral	13	2.5
University level	Vocational colleges	278	53.56
	Universities	241	46.44
University category	Public	480	92.49
	Private	39	7.51

The values of Cronbachs' alpha, construct reliability (CR), and average variance extracted (AVE) were presented in Table 3. The Cronbachs' alpha and CR values of eight factors exceed 0.8, and all AVE values exceed 0.6. The reliability and validity of data are confirmed.

Table 2. Mean, Standard deviation, excess kurtosis and skewness

	Mean	Std. dev	Excess kurtosis	Skewness	PLS loadings
PE1	5.547	1.614	0.456	−1.063	0.901
PE2	5.53	1.555	0.668	−1.078	0.918
PE3	5.385	1.644	0.306	−1.002	0.93
PE4	5.013	1.726	−0.306	−0.677	0.868
EE1	5.476	1.441	0.466	−0.866	0.848
EE2	5.522	1.392	0.452	−0.863	0.881
EE3	5.491	1.454	0.511	−0.929	0.856
EE4	5.008	1.558	−0.062	−0.62	0.748
SI1	5.071	1.78	−0.284	−0.753	0.87
SI2	4.792	1.768	−0.485	−0.574	0.945
SI3	4.705	1.781	−0.593	−0.49	0.929
FC1	5.283	1.621	0.236	−0.897	0.854
FC2	5.461	1.506	0.645	−1.007	0.851
FC3	5.364	1.627	0.272	−0.947	0.727
FC4	5.106	1.636	−0.182	−0.722	0.758
HM1	4.825	1.657	−0.248	−0.588	0.943
HM2	4.788	1.672	−0.389	−0.506	0.941
HM3	4.366	1.692	−0.6	−0.344	0.864
PV1	4.322	1.666	−0.596	−0.243	0.882
PV2	4.617	1.589	−0.354	−0.402	0.9
PV3	4.593	1.61	−0.381	−0.411	0.908
HB1	4.337	1.793	−0.784	−0.295	0.866
HB2	3.449	1.834	−1.013	0.156	0.841
HB3	3.649	1.89	−1.044	0.109	0.789
HB4	4.611	1.704	−0.58	−0.368	0.784
BI1	5.158	1.63	−0.204	−0.687	0.944
BI2	5.143	1.604	0.032	−0.75	0.957
BI3	5.056	1.642	−0.185	−0.669	0.945

In Table 4, the correlation analysis of eight constructs was conducted. It shows that the square root of each AVE is larger than its construct correlations, indicating the data's relatively independence of one another.

The f^2 of HB and PE are 0.070 and 0.066 respectively, which are both more than 0.02. These results re-examined the validity of the data.

The heterotrait-monotrait ratio of correlations (HTMT) was presented in Table 5. Each value of eight constructs is less than 0.85, indicating the reliability.

Table 3. Cronbachs' alpha, CR, and AVE

	Cronbachs' alpha	CR	AVE
BI	0.944	0.964	0.9
EE	0.855	0.902	0.697
FC	0.812	0.876	0.639
HM	0.905	0.94	0.84
HB	0.838	0.892	0.674
PE	0.926	0.948	0.819
PV	0.878	0.925	0.804
SI	0.903	0.939	0.838

Table 4. Square roots of AVEs

	BI	EE	FC	HB	HM	PE	PV	SI
BI	0.949							
EE	0.424	0.835						
FC	0.578	0.554	0.8					
HB	0.627	0.457	0.542	0.821				
HM	0.627	0.389	0.641	0.613	0.917			
PE	0.63	0.429	0.592	0.523	0.679	0.905		
PV	0.523	0.369	0.525	0.618	0.621	0.442	0.897	
SI	0.521	0.329	0.547	0.533	0.576	0.547	0.467	0.915

Table 5. HTMT

	BI	EE	FC	HB	HM	PE	PV	SI
BI								
EE	0.46							
FC	0.65	0.652						
HB	0.698	0.518	0.65					
HM	0.676	0.425	0.746	0.7				
PE	0.673	0.462	0.669	0.585	0.739			
PV	0.573	0.409	0.622	0.717	0.698	0.486		
SI	0.564	0.355	0.631	0.606	0.636	0.596	0.523	

4.3 Results of PLS-SEM Analysis

Figure 2 shows the results of PLS-SEM analysis. Bootstrapping was performed using 519 responses to 5000 samples to evaluate the significance of the path coefficients.

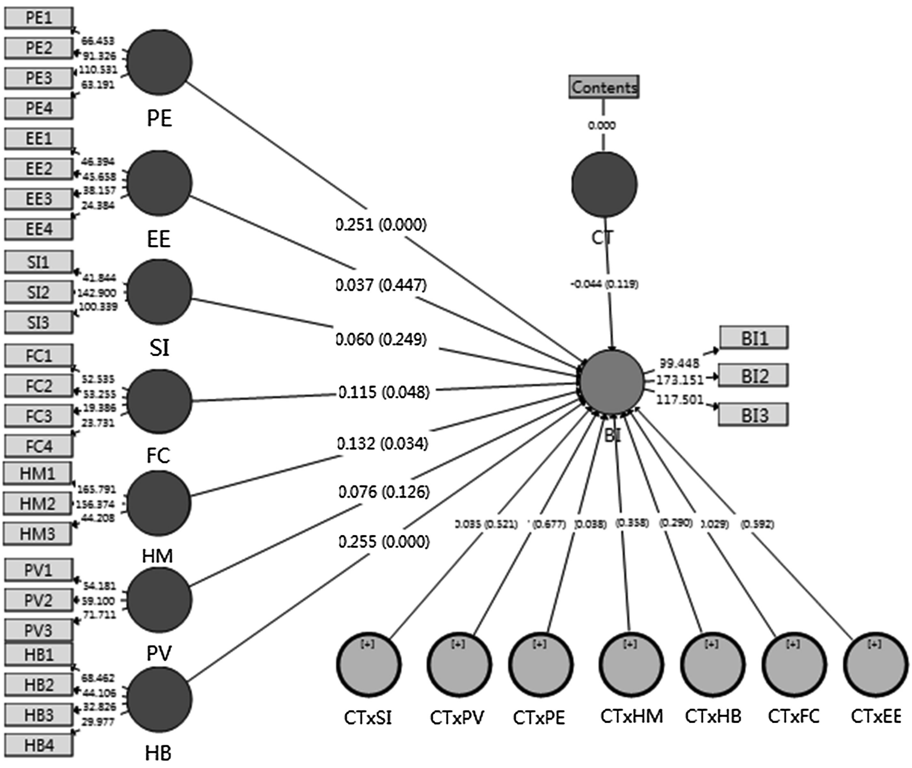

Fig. 2. Results of PLS-SEM analysis

5 Discussion and Conclusion

According to the Partial Least Squares-Structural Equation Modelling (PLS-SEM) results, the value of R^2 in the research model is 0.569, which is more than 0.25. It can be described as ‘substantial’ (Hair and Sarstedt 2011). The P-values of PE, FC, HM, HB, CTxPE, CTxFC, are less than 0.05. It means PE, FC, HM and HB have significant effect on BI, indicating that Hypotheses 1, 3, 5, 7 are assisted, but Hypotheses 2, 4, 6 are not assisted, Hypothesis 8 is partially accepted where content moderates the effect of PE and FC on BI toward E-learning of university teachers. University teachers like to use E-learning to pursue further education is because of its efficiency. Facilitating conditions and whether the E-learning courses are entertaining are also crucial factors. But the habit of using E-learning affects the user behavioral intention most strongly (β = 0.255). The more time users devoted in E-learning, the more likely they would have continuance use. This conclusion is consistent with Table 7.

Table 6. Results of PLS-SEM

Factor → Behavioral Intention (BI)	Beta value	P-value	
H1: Performance Expectancy (PE) → BI	0.251	0.000	**Accept**
H2: Effort Expectancy (EE) → BI	0.037	0.447	Reject
H3: Facilitating Conditions (FC) → BI	0.115	0.048	**Accept**
H4: Social Influence (SI) → BI	0.060	0.249	Reject
H5: Hedonic Motivation (HM) → BI	0.132	0.034	**Accept**
H6: Price Value (PV) → BI	0.076	0.126	Reject
H7: Habit(HB) → BI	0.255	0.000	**Accept**
H8: CTxPE → BI	−0.097	0.038	**Accept**
CTxFC → BI	0.123	0.029	**Accept**

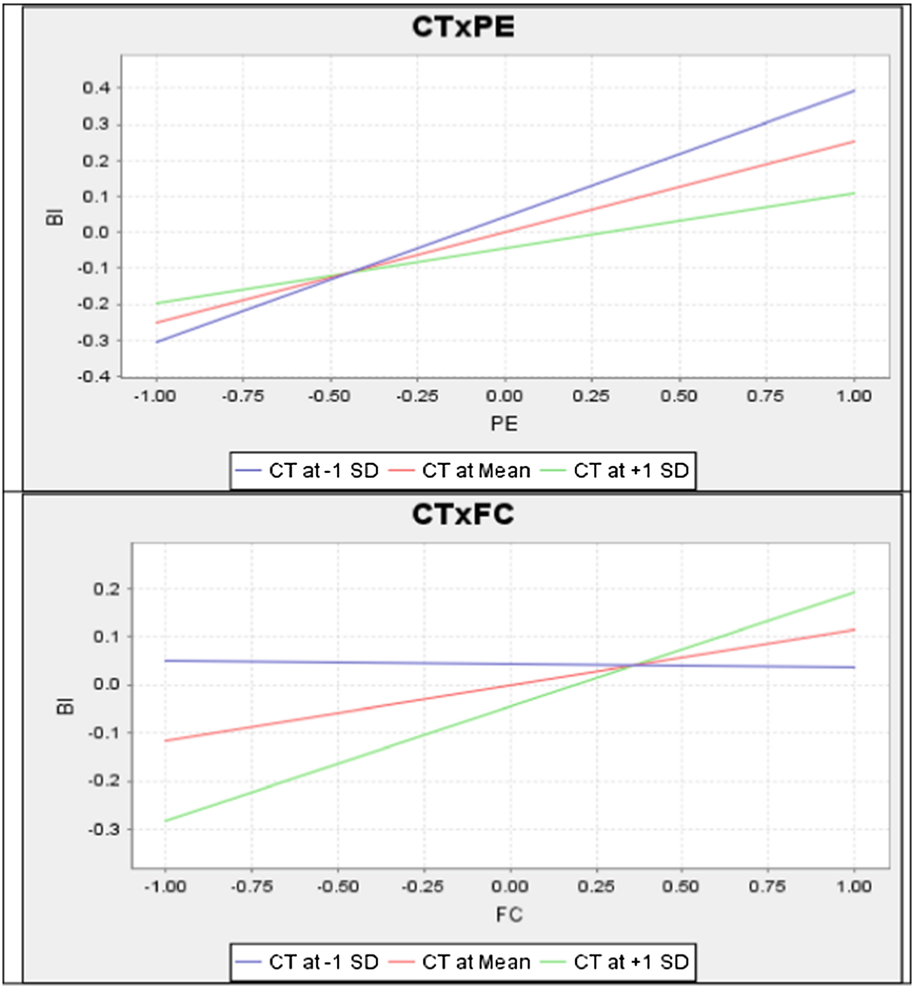

Fig. 3. Simple slope analysis

Table 7. Time of using E-learning (n = 519)

		Frequency	Percentage
Time	0–1 years	140	26.97
	2 years	111	21.39
	3 years	86	16.57
	4 years	56	10.79
	5 years	53	10.21
	6 years	15	2.89
	7 years or above	58	11.18

Figure 3 re-examines CT's moderating effects of PE and FC on BI.

Content of the E-learning (CT) has moderating effects of Performance Expectancy (PE) and Facilitating Conditions (FC) on the university teachers' Behavioral Intention (BI). Most of the university teachers used E-learning to pursue professional skills (45.86%) and professional studies (32.56%). The number of teachers studying for certificate/ Examination took up 11.95%, and others for customized training amounted to 9.63% (Table 8).

Table 8. Contents of E-learning courses (n = 519)

		Frequency	Percentage
Contents	Professional skills	238	45.86
	Professional studies	169	32.56
	Customized training	50	9.63
	Certificate/examination	62	11.95

More than half of the university teachers chose Government-affiliated institutions of E-learning (58.38%). Those from private enterprises and association of industries composed 24.28% and 17.34% respectively (Table 9).

Table 9. Suppliers of E-learning (n = 519)

		Frequency	Percentage
Supplier	Government-affiliated institutions	303	58.38
	Private enterprises	126	24.28
	Association of industries	90	17.34

To achieve target return and gain competitive advantage in the continuing education market sector, the service providers of continuing education should focus more on the core value of the contents to meet with the demand of university teachers, and avoid inaccurate learning positioning for learners, single form of learning resources, unscientific knowledge structure, inadequate management functions, lack of interactive functions, and useless learning resources in digital curriculum.

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The Impact of Personal Innovativeness on the Intention to Use Cloud Classroom: An Empirical Study in China

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Abstract. The object of this research is to examine the elements that influence students' behavioral intention towards using a Cloud Classroom App (CCA) platform in China. In this study, Partial least squares (PLS) analysis is adopted to analyze the data collected from 998 students in Guangzhou. The empirical data reveal that performance expectancy, effort expectancy, social influence, facilitating conditions, and personal innovativeness in information technology positively affect students' behavioral intention toward using a CCA platform to obtain knowledge. Moreover, effort expectancy has a partially mediating effect between personal innovativeness in information technology and performance expectancy, and performance expectancy also as a mediator variable partially affects the relationship between personal innovativeness in information technology and behavior intention, effort expectancy and behavior intention, respectively. The results of the multi-group analysis show that there are significant differences in the use of a CCA platform for learning between the junior students (year 1) and senior students (years 2 & 3). This study makes several recommendations to the CCA platform managers to make improvements to the design of the CCA platform.

Keywords: Personal innovativeness · Cloud classroom · Intention to use · UTAUT

1 Introduction

In China, the "Internet +" education trend prompts the development of different online platforms for students to learn anytime and anywhere, such as school online, blue ink cloud class, and cloud classroom application (CCA), etc. Every platform has its special features supporting students' online learning through their phone. The CCA platform is a digital learning center specifically for vocational education which is built and

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operated by the Higher Education Press and is the only platform that integrates national project achievements and its own resources to build exclusive online courses to help cultivate high-quality skilled talents for the whole society.

Nowadays CCA is widely used by vocational colleges because it has high-quality teaching resources, a powerful question bank, and supportive of remote control for ppt/word/video. This way of mobile learning can make class activities diverse and vivid, is more convenient and faster for students to learn. However, in the meantime, the results of the adoption of CCA into the real classroom for students to achieve satisfactory learning don't go well. One of the reasons is that some teachers find it difficult to plan online learning materials for students. Furthermore, students concern that they may lack face-to-face interaction with the tutor and therefore reduce social and cultural interaction, etc. [8, 20].

So as to stimulate more students to adopt this app, the aim of this research is to investigate what elements would significantly affect the acceptance of the CCA based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model. This study examines the influences of the elements of UTAUT including Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), and Personal Innovativeness in Information Technology (PIIT) on the behavioral intention (BI) toward using the CCA for higher vocational students to learn courses. Furthermore, it also examines whether EE has a mediating effect between PIIT and PE, and PE as a mediator variable affects the relationship between PIIT and BI, EE and BI, respectively. Lastly, it explores any differences regarding the acceptance of the CCA among different years of students.

2 Literature Review

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

In 2003, Venkatesh et al. [21] synthesized eight technology acceptance models to establish the UTAUT model to explain individual technology adoption including the Theory of Reasoned Action (TRA) [3], the Theory of Planned Behavior (TPB) [2], the Technology Acceptance Model (TAM) [5], the Combined-TAM-TPB [17], Model of PC Utilization (MPCU) [18], Motivational Model (MM) [6], Social Cognitive Theory (SCT) [4] and Innovation Diffusion Theory (IDT) [15]. The UTAUT model has been empirically tested and verified more advantageous compared to other popular models [21], many scholars used the UTAUT model in various scenarios. From the perspective of education, Lai et al. [10] added an important element the "political influence" to the UTAUT model to discuss the student acceptance of the electronic schoolbag system in Mainland China. Yang et al. [22] applied UTAUT to study the elements of m-learning platform acceptance in Macau and to discuss if there exists gender difference in the acceptance of m-learning platform. However, from current literature, no studies have used this model to investigate higher vocational college students' acceptance of the CCA.

2.2 Personal Innovativeness in Information Technology (PIIT) Research

PIIT means that an individual would like to employ new technology [1]. Current research has verified that PIIT has a significant influence on perceived usefulness and perceived ease of use [9, 14, 16, 19]. Lewis et al. [11] found PIIT relationships with perceived usefulness and perceived ease of use. Lu et al. [12] also found that PIIT had a significant influence on perceived usefulness and perceived ease of use as proposed by Agarwal and Prasad [1]. Okumus et al. [13] found that the degree of user innovativeness affects customers' intention to adopt diet apps.

3 Research Method

3.1 Research Model

As mentioned earlier, PE, EE, SI, FC, PIIT may have positive effects on BI toward using the CCA for students' learning; EE may have a mediating effect between PIIT and PE, and PE also as a mediator variable may affect the relationship between PIIT and BI, EE and BI, respectively. Eight hypotheses were developed as follows. Figure 1 shows the research model.

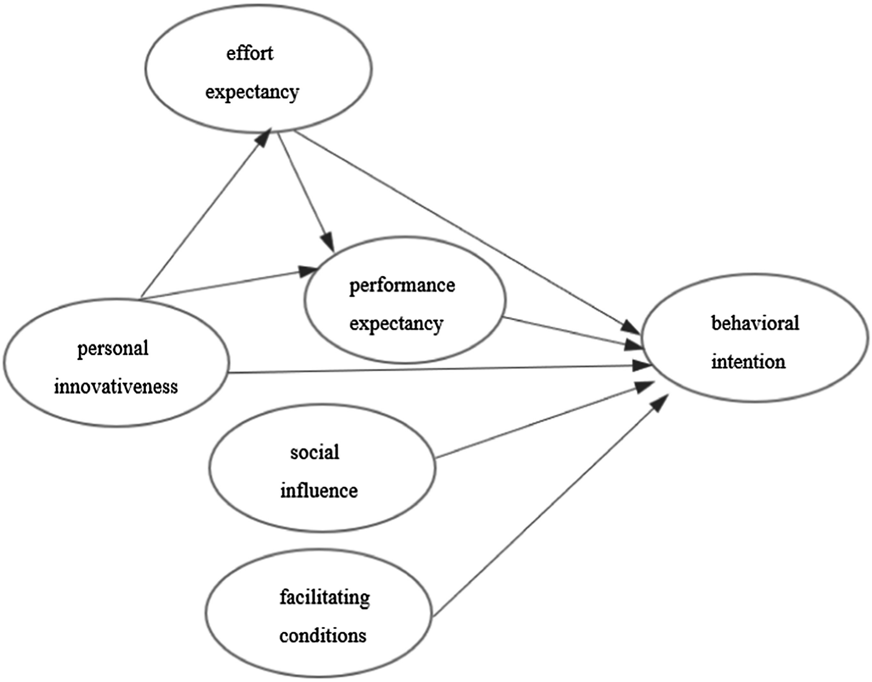

Fig. 1. Research model.

H1: Effort expectancy positively influences students' behavioral intention to use the CCA.

H2: Performance expectancy positively influences students' behavioral intention to use the CCA.

H3: Personal innovativeness in information technology positively influences students' behavioral intention to use the CCA.

H4: Social influence positively influences students' behavioral intention to use the CCA.

H5: Facilitating conditions positively influences students' behavioral intention to use the CCA.

H6: Effort expectancy positively influences Performance expectancy for students to adopt the CCA.

H7: Personal innovativeness in information technology positively influences Effort expectancy for students to adopt the CCA.

H8: Personal innovativeness in information technology positively influences performance expectancy for students to adopt the CCA.

3.2 Data Collection

In October 2017, School of Finance and Economics in Guang Zhou Pan Yu Polytechnic launched a program for fully promoting the application of cloud classroom in daily teaching which involved nearly 70 teachers and 1700 students. Therefore, this school as a pioneer unit is suitable to examine the elements that affect students' acceptance of the CCA. A questionnaire survey was carried out there from July to December 2018. Finally, a total of 1532 questionnaires was collected online. However, 534 questionnaires were dropped because of invalid answers, leaving 998 questionnaires as eligible for research. The basic information of the respondents is as follows (Table 1).

Table 1. Summary of respondent background (N = 998).

		Frequency	Percentage
Gender	Male	140	14.03
	Female	858	85.97
Age	Under 18	31	3.11
	18–22	958	95.99
	Over 22	9	0.90
Grade	Grade-1	362	36.27
	Grade-2	426	42.69
	Grade-3	210	21.04
Self-learning type	Yes	444	44.49
	No	554	55.51

4 Findings

4.1 Validity and Reliability

In this study, Smart PLS version 3.2.7 was used because it can resolve problems of complicated models and deal with small samples [7]. Table 2 shows the means, standard deviations, and PLS loadings. All factor loadings surpass 0.7 which is suggested number.

Table 2. Means, standard deviations, and pls loadings.

Construct	Mean	Std. dev.	PLS loading
PE1	4.882	1.005	0.921
PE2	4.840	1.029	0.943
PE3	4.845	1.039	0.939
EE1	5.077	0.946	0.886
EE2	5.160	0.960	0.913
EE3	5.166	0.961	0.910
SI1	5.093	1.010	0.701
SI2	4.472	1.113	0.901
SI3	4.267	1.244	0.861
FC1	4.952	0.946	0.897
FC2	4.946	0.996	0.886
FC3	5.318	0.993	0.803
PIIT1	4.700	0.982	0.828
PIIT2	5.046	0.934	0.889
PIIT3	5.030	0.920	0.867
BI1	4.868	0.906	0.924
BI2	4.887	0.943	0.924
BI3	4.834	1.002	0.909

As shown in Table 3, the values of Average Variance Extracted (AVE) and Cronbach's Alpha surpass 0.5 and 0.7 respectively in the six constructs. The Composite Reliability (CR) values all surpass 0.8. The square-root of the construct's AVE surpasses its correlations with other constructs in the model. Therefore, the captioned results show that the design of the questionnaire and responses are believable.

Table 3. Reliability, validity, and corrections of the constructs.

	Cronbach's alpha	CR	AVE	BI	EE	FC	PE	PIIT	SI
BI	0.908	0.942	0.844	0.919					
EE	0.887	0.930	0.816	0.579	0.903				
FC	0.828	0.897	0.745	0.692	0.613	0.863			
PE	0.927	0.954	0.873	0.668	0.636	0.642	0.934		
PIIT	0.827	0.896	0.743	0.563	0.465	0.489	0.430	0.862	
SI	0.760	0.864	0.681	0.540	0.442	0.518	0.547	0.383	0.826

Note. AVE = average variance extracted; CR = composite reliability.

4.2 Testing of Hypotheses

The explication ability of the research model can be determined by testing the R^2 values of the constructs. The model explains 61.90% of variance in behavior intention. Figure 2 shows the test results intuitively.

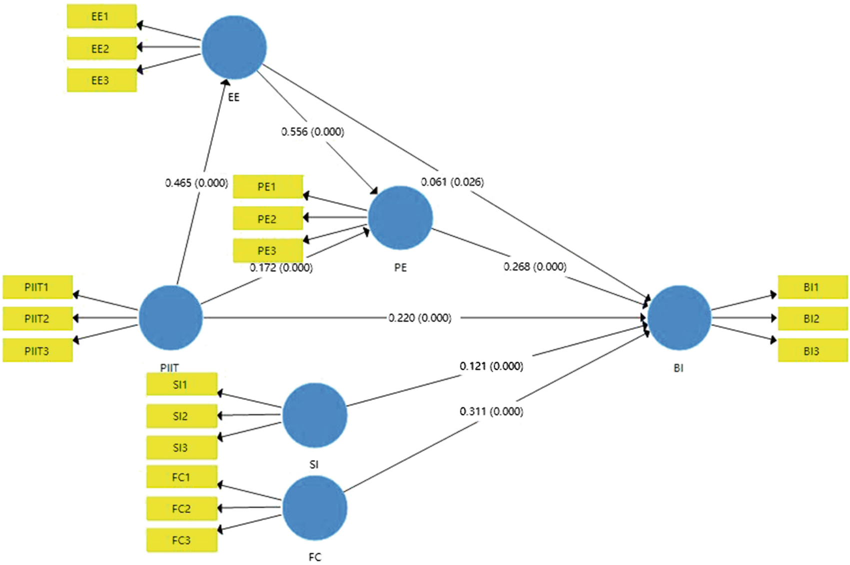

Fig. 2. Results of PLS-SEM analysis

Moreover, a bootstrapping analysis was conducted from a sample size of 998 to 5000, the purpose is to evaluate the significance of the path coefficients among these six constructs which are presented in Table 4. The analysis results show that the p-values of all five elements are lower than 0.05. Consequently, all the hypotheses are supported. Table 4 and Fig. 2 show the outcomes of the PLS-SEM.

Table 4. Structural estimates (hypotheses testing).

Hypotheses	Coefficients	P value	Decision
EE -> BI	0.061*	0.026	Supported
EE -> PE	0.556***	0.000	Supported
FC -> BI	0.311***	0.000	Supported
PE -> BI	0.268***	0.000	Supported
PIIT -> BI	0.220***	0.000	Supported
PIIT -> EE	0.465***	0.000	Supported
PIIT -> PE	0.172***	0.000	Supported
SI -> BI	0.121***	0.000	Supported

Note. *P < .05, **P < .01, ***P < .001.

5 Discussion and Conclusions

Facilitating conditions are the most critical factor of students' behavioral intention toward using the CCA ($\beta = 0.311$, $p = 0.000$). EE, PE, PIIT, and SI are also determining factors of user behavioral intention toward using CCA for students ($\beta = 0.061$, $p = 0.026$; $\beta = 0.268$, $p = 0.000$; $\beta = 0.220$, $p = 0.000$; $\beta = 0.121$, $p = 0.000$; respectively).

The effect of EE on students' behavioral intention toward using the CCA is significant. It indicates that students are willing to use the CCA because of its convenience to learn their courses.

PE shows a significant effect on students' behavioral intention toward using the CCA. This indicates that students think they can get benefits from using the CCA, such as various learning materials and different teaching style to make students think more openly and study more interesting.

PIIT and SI also affect student acceptance of the CCA. Students' intentions will be positively affected if a student has an innovative personality, particularly students will be influenced by people around them.

Facilitating conditions play a majority role in the adoption of the CCA. The survey was conducted not long after launching the CCA, so relevant resources are not quite in position. That's why facilitating conditions are so important for students to consider while using the CAA. In addition, from the interview results of teachers and students after the survey, they consistently reflected the problem of unsmooth network. It is urgently needed for relevant information department to speed up the network.

The results also indicate that EE has a mediating effect between PIIT and PE, and PE also as a mediator variable affects the relationship between PIIT and behavioral intention, effort expectancy and behavioral intention, respectively. Table 5 shows the direct, indirect, and total effects among the different constructs.

Table 5. Direct, indirect, and total effects.

	BI			PE			EE
	Direct	Indirect	Total	Direct	Indirect	Total	Direct
EE	0.061	0.149	0.211	0.556			
FC	0.311		0.311				
PE	0.268		0.268				
PIIT	0.220	0.144	0.364	0.172	0.259	0.430	0.465
SI	0.121		0.121				

Note. $*P < .05$, $**P < .01$, $***P < .001$.

This study also considered the differences across different years of students. The results of Multi-group analysis (MGA) show that there is a significant difference between year1 and year-2 students in the path coefficients for the impact of EE on PE (As shown in Table 6), the effect of EE on PE for year 1 students is higher than year 2 students., For year-1 students, their learning efficiency will be improved if the CCA is easy for them to use, this is because they are freshmen and are not as familiar with the

CCA as sophomore students from the year-2 students. Differences were also found between year-1 and year-2/year-3 students in the path coefficients for the impact of SI, PIIT and FC on behavioral intention (as shown in Table 6 and 7). It suggests that in comparison to year-2/year-3 students, year-1 students consider FC more while intending to adopt the CCA because they had entered college and used the CCA for only one month when the questionnaire survey was conducted. They were still confused about how to connect the network when shifting teaching buildings. They will incline to use the CCA in the future. If related resources are better positioned, they will much more willing to use the CCA to learn courses. After a period of the launch of the CCA, teachers used to publish school assignments and tests through the CCA. Year-2/year-3 students concerned that they may miss any tasks on the CCA, so they will strongly be influenced by their classmates and teachers, especially the poor learning students who have not yet got enough credits to meet graduation requirements. Additionally, after the curiosity period of learning through the CCA, with the upgrading version of the CCA, year-2/year-3 students of with innovative personality are naturally inclined to continue to explore new areas of the CCA.

In conclusion, the results of PLS analysis indicate that PE, EE, SI, FC, and PIIT have direct effect on user behavioral intention toward using the CCA for students to

Table 6. Structural estimates across year-1 and year-2.

Relationships	Path coefficients diff (year-1–year-2)	P value
EE -> BI	0.028	0.317
EE -> PE	0.121*	0.026
FC -> BI	0.287*	0.000
PE -> BI	0.013	0.571
PIIT -> BI	0.182*	0.998
PIIT -> EE	0.000	0.499
PIIT -> PE	0.102	0.937
SI -> BI	0.176*	0.998

Note. *P < 0.05, *P > 0.95.

Table 7. Structural estimates across year-1 and year-3.

Relationships	Path coefficients diff (year-1–year-3)	P value
EE -> BI	0.074	0.159
EE -> PE	0.036	0.285
FC -> BI	0.234*	0.005
PE -> BI	0.027	0.376
PIIT -> BI	0.146*	0.976
PIIT -> EE	0.016	0.593
PIIT -> PE	0.046	0.752
SI -> BI	0.214*	0.997

Note. *P < 0.05, *P > 0.95.

learn courses and EE has a mediating effect between PIIT and PE, PE also as a mediator variable affects the relationship between PIIT and BI, EE and BI, respectively. There is a significant difference between year-1 and year-2 students for the impact of EE on PE. It also found that there were differences between year-1 and year-2/year-3 students for the impact of SI,PIIT and FC on BI. This study makes several recommendations to the CCA operators for improving the design of the CCA. It also helps educators to establish their strategies to promote the use of the CCA as well as cloud education.

6 Limitations and Future Studies

There are still some limitations in this study. First, the research data was from online and limited to students from higher vocational colleges in Guangzhou. Future research should involve more cities, more colleges, and more participants to improve data representativeness. Second, some online learners expressed their concern about the charges of some online courses are too high. Further research is expected to find out whether the price is a crucial element that would affect students' intention to use the CCA. Third, this study finds that neither age nor gender moderates the relationships, but there may be other potential constructs that may moderate the relationships, (e.g., personal traits, experience, and voluntariness of use). Further researches may use different models and take them into consideration.

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Teaching and Learning Analysis and Assessment

Mobile Learning in Health-Related Disciplines (2009–2018): A Review of Case Studies with the FRAME Model

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Abstract. In the past decade, mobile learning has become one of the mainstream channels for delivering education in various disciplines. Health-related education is an area which is regarded as suitable for the use of mobile devices because of its various learning environments, such as classrooms, laboratories and wards. This paper presents a comprehensive review of the case studies on mobile learning in health-related disciplines in the period 2009–2018. The Framework for the Rational Analysis of Mobile Education (FRAME) (Koole 2009) was adopted as the model for analysis, which conceptualises mobile learning as an intersection of the device, learner and social aspects. A total of 62 relevant papers were collected from Scopus and the Web of Science. The results showed an increasing number of practices in various countries over the years. The practices in recent years have focused less on the hardware capabilities of mobile devices and more on the effects of mobile learning on learners, such as enhancing their understanding of concepts and their ability to apply information to unique situations and needs. Finally, the research trends and needs of mobile learning in health-related disciplines are discussed.

Keywords: Mobile learning · Health-related disciplines · FRAME model

1 Introduction

With the advances in mobile technology and prevalence of mobile devices, mobile learning has been practised in various disciplines in recent decades. Mobile learning has been defined as learning which takes place with the aid of mobile technology, without being confined to a fixed location (Sharples 2000). The benefits of mobile learning have been widely reported, covering, for example, the greater access to information, enhanced interaction with peer learners and teachers, and a more satisfactory learning experience (Heflin et al. 2017).

Disciplinary practice of mobile learning has been identified as an area worth further investigation. In particular, Hwang and Wu (2014) found that previous mobile learning practices were adopted in only a few disciplines such as languages and computer sciences, which suggests that the learning context of a discipline may be a factor which influences the adoption of mobile learning.

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This paper focuses on the mobile learning practices in health-related disciplines, such as nursing, medicine, pharmacy and dentistry, which are classified as professions and applied sciences (Wu et al. 2012). Li et al. (2018) pointed out that these disciplines have diverse learning environments ranging from classrooms to laboratories and wards, which serve as a suitable context for practising mobile learning. Despite a significant number of mobile learning studies having been conducted in these disciplines, previous reviews have only covered their major patterns in generic areas such as devices, environments, research methods, benefits, and outcomes (e.g. Chang et al. 2018; Lee et al. 2018; O'Connor and Andrews 2015). Rarely has a theoretical basis been used for analysing the mobile learning practices.

This study adopted the Framework for the Rational Analysis of Mobile Education (FRAME model) (Koole 2009; Koole et al. 2018) for analysing a total of 62 mobile learning practices in health-related disciplines published in the past 10 years (2009–2018). The FRAME model has been widely applied for guiding the design and evaluation of mobile learning practices (Koole et al. 2018; Li et al. 2017). Based on this model, the features and trends of mobile learning in health-related disciplines were identified, showing the further work which needs to be done for advancing mobile learning development in these disciplines.

2 Literature Review

2.1 Mobile Learning in Health-Related Disciplines

Education in health-related disciplines emphasises not only knowledge discovery but also skill acquisition. In addition to the disciplinary subject matter taught in classrooms, students in health-related education also need to become familiar with the workplace contexts, such as hospital wards for nursing students. The ubiquitous nature of mobile learning allows learners to access just-in-time information and engage in situated, experimental and contextualised learning tasks (Kukulska-Hulme and Traxler 2005). For example, Li et al. (2019) studied the use of mobile devices for helping nursing students to understand nursing concepts and memorise clinical terminology, and both students' learning motivation and study performance were improved.

Existing reviews of mobile learning in health-related disciplines have focused mainly on some generic areas. For example, Dunleavy et al. (2019) conducted a meta-analysis of mobile learning studies on health professional education to assess their effectivess in enhancing learners' knowledge, skills, attitudes and satisfaction. The review by Curran et al. (2017) covered the background of learners, digital technologies, social networking tools, and evaluation outcomes. Walsh (2015) studied the advantages and disadvantages of mobile learning in medical education. Also, O'Connor and Andrews (2015) summarised the variety of mobile devices and applications, the benefits of mobile platforms, and the sociotechnical factors which affect their use in nursing education. However, these reviews are limited by the lack of a theoretical basis to investigate the specific aspects of mobile learning practices.

2.2 The FRAME Model

The FRAME model (Koole 2009; Koole et al. 2018) conceptualises mobile learning as an interaction between three major aspects—mobile technologies (device), human learning capacities (learner), and social interaction (social). The model addresses pedagogical issues in mobile learning, such as information overload, knowledge navigation, and collaboration in learning. It has been widely applied for guiding the design, implementation and evaluation of mobile learning practices in both formal and informal learning (e.g. Kenny et al. 2009; Mahande et al. 2017; Park et al. 2010).

In the FRAME model, learners take in and create information collectively and individually through mobile technology. The interaction between the device (D), learner (L), and social (S) aspects results in the features of device usability (DS), interaction learning (LS), social technology (DS), and an ideal mobile learning process (DLS) which enhances “collaboration among learners, access to information, and a deeper contextualisation of learning” (Koole 2009, p. 38). There are 26 criteria included in these seven aspects, providing a comprehensive guide for devising effective mobile learning practices through assessing the extent to which the features of the FRAME model are fulfilled in the practices.

3 Methodology

This study aims to review the practices of mobile learning in health-related disciplines using the FRAME model to identify the major patterns and trends. Relevant studies published in the past ten years (2009–2018) were collected from Scopus and the Web of Science, using the keywords “mobile learning” and “health”. A total of 94 results were initially collected. Each of them was checked to include only those reporting mobile learning practices in disciplines related to healthcare, such as medicine, nursing, health professions, pharmacy, and dentistry. Only journal articles in English were included. Articles were excluded if they (1) focused simply on the use of technology in education, not specifically on mobile learning; (2) did not involve an empirical mobile learning practice, such as a literature review or discussion paper; and (3) did not fit into any criteria of the FRAME model. After further checking, in the end 62 studies were identified as relevant and selected.

The selected mobile learning practices were examined against the 26 criteria covered in the seven aspects of the FRAME model, and assessed on whether they had addressed the criteria based on the description of the practices. In addition, the practices which had addressed the criteria were divided into two groups according to their year of publication—2009–2013 and 2014–2018—for comparison and identification of the trends.

4 Results

4.1 Overview of the Mobile Learning Practices

Figure 1 illustrates the year of publication for the mobile learning practices, showing an overall upward trend in their number. This result indicates that mobile learning had been used increasingly in health-related education.

Figure 2 shows the countries/regions involved in the mobile learning practices for the two periods. The largest proportion of the practices were conducted in the USA, followed by the UK, Taiwan and Australia. Comparing the two periods, it is clear that many more countries were involved in the second period, including in particular some developing countries such as Botswana and Peru. Proportionally, the percentages of practices decreased for some developed countries such as Australia and Canada, while there is less difference in terms of the numbers of practices because of the more cases in the second period. These results show that mobile learning had become more widespread in various parts of the world.

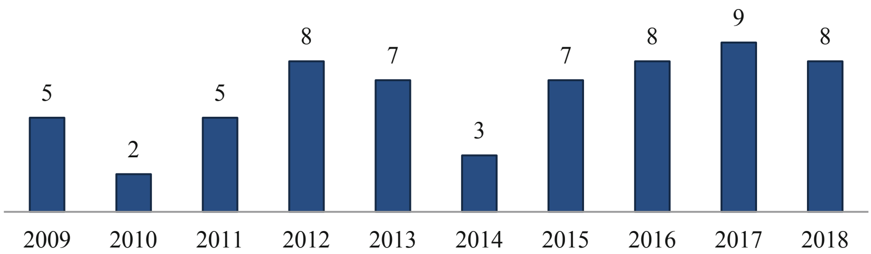

Fig. 1. Year of publication for the mobile learning practices

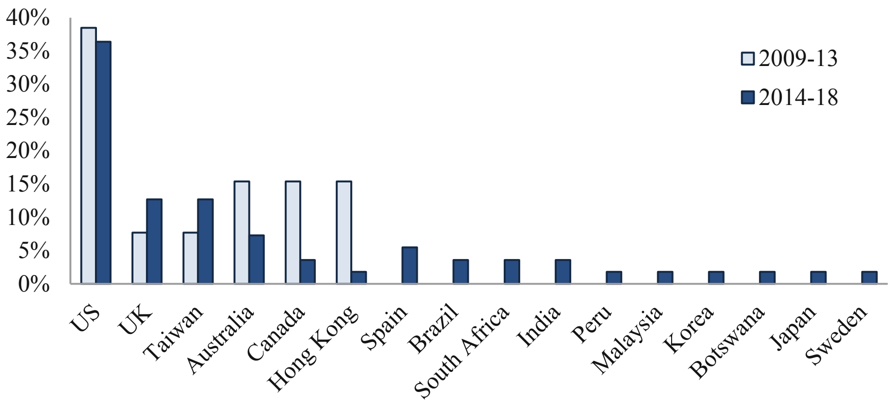

Fig. 2. Countries/regions of the mobile learning practices

4.2 Device Aspect

The device aspect of the FRAME model refers to the physical, technical, and functional characteristics of mobile devices (Koole 2009). It includes six criteria: (1) physical characteristics; (2) input capabilities; (3) output capabilities; (4) file storage and retrieval; (5) processor speed; and (6) error rates. These criteria address the hardware and software design of a device and have a significant impact on its usability.

Figure 3 shows the proportion of the mobile learning practices which address the criteria in the device aspect. The "physical characteristics" such as the size and weight of a device are most commonly addressed in the practices. The "input capabilities" (e.g. efficiency of input methods) were mentioned less, particularly in the second period, as not every practice required users to input data using the devices. The "output capabilities" are usually related to the screen size and resolution of devices. For both periods, mobile devices were often criticised for their small screen size and resolution, which made it difficult for learners to engage with course contents. For "file storage and retrieval", more than half of the practices in the first period stated the problem of limited storage space which prevented learners from installing useful tools and resources. The storage problem was reduced in the second period as the storage capacity of mobile devices had been increasing. "Processor speed" and "error rates" were not frequently mentioned in either period. Some practices addressed the short battery life, network connection problems or software functional problems.

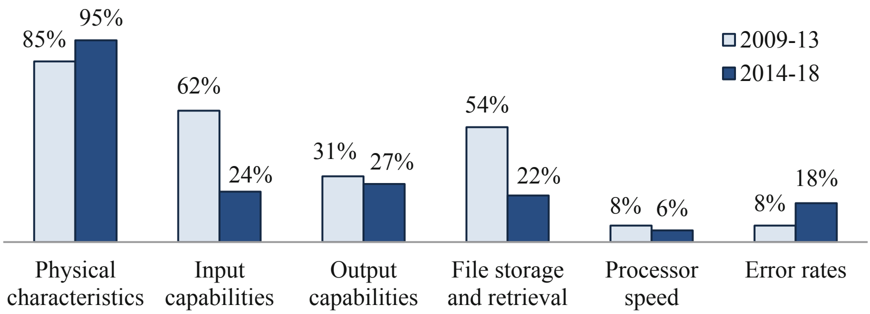

Fig. 3. Proportion of practices addressing the device aspect

4.3 Learner Aspect

The learner aspect takes into account one's "cognitive abilities, memory, prior knowledge, emotions, and possible motivations", and describes "how learners use what they already know and how they encode, store, and transfer information" (Koole, 2009, pp. 29–30). There are five criteria in this aspect: (1) prior knowledge; (2) memory; (3) context and transfer; (4) discovery learning and (5) emotions and motivation.

Figure 4 presents the proportion of practices addressing the criteria in the learner aspect. The "prior knowledge" of learners affects how easily they can understand new concepts or assimilate bias. In both periods, more than 30% of the practices addressed this criterion, which were mainly about the prior knowledge required for using mobile devices. "Memory" refers to the use of contextual cues, such as multimedia, to help learners understand and retain concepts more easily. This was addressed more frequently in the second period, with practices focusing on retaining concepts in specific situations and supporting critical thinking activities. "Context and transfer" focuses on applying concepts or knowledge in varied contexts. Despite a similar proportion of practices in both periods, there was a trend for those in the second period to be concerned more with how students could apply knowledge in work practices rather than only in exams. "Discovery learning" emphasises solving novel problems. For example, Alvarez et al. (2017) adopted mobile technology to create various problem scenarios for learners to solve. "Emotions and motivations" refers to a learner's feelings about a task and reasons for accomplishing it, which may affect his/her willingness to adopt new information. Relatively fewer practices in both periods addressed this criterion. Dearnley et al. (2008) found that students were anxious about the reliability of devices and the possibility of losing the data in the devices.

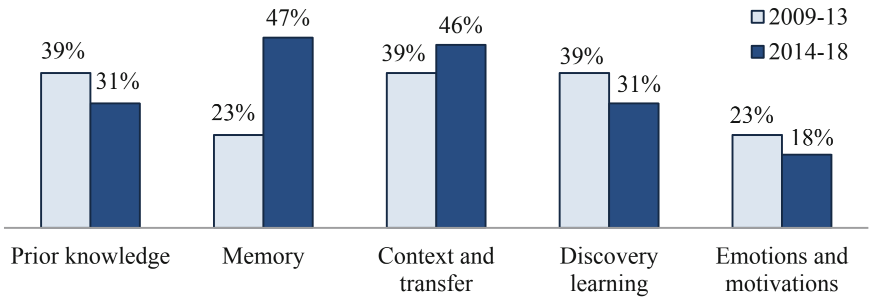

Fig. 4. Proportion of practices addressing the learner aspect

4.4 Social Aspect

The social aspect covers social interaction and cooperation. Learners must follow the norms of communication to exchange information, acquire knowledge, and sustain cultural practices. This includes two criteria: (1) conversation and cooperation, and (2) social interaction.

Figure 5 shows the proportion of practices addressing the two criteria. "Conversation and cooperation" refers to the factors that restrict or reduce the effectiveness of communication. For example, Alvarez et al. (2017) investigated the use of a Facebook group or Messenger to promote students' communication when studying in a group. "Social interaction" addresses the importance of having common signs and symbols for effective communication. In the second period, a lower proportion of the practices addressed this criterion, possibly because mobile communication had become more commonplace and there was no need to emphasise it in the practices.

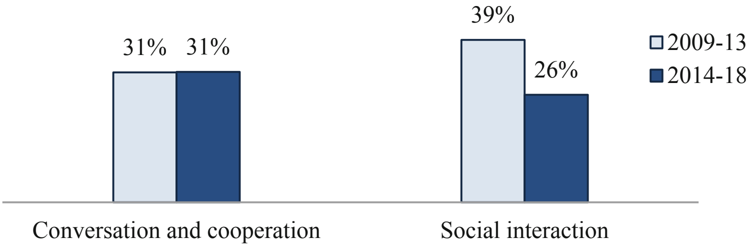

Fig. 5. Proportion of practices addressing the social aspect

4.5 Device Usability

The device usability covers both the device and learner aspects. It "relates characteristics of mobile devices to cognitive tasks relevant to the manipulation and storage of information" (Koole 2009, p. 32), which, in turn, affect learners' sense of psychological comfort and satisfaction. The device usability includes four criteria: (1) portability; (2) information availability; (3) psychological comfort; and (4) satisfaction.

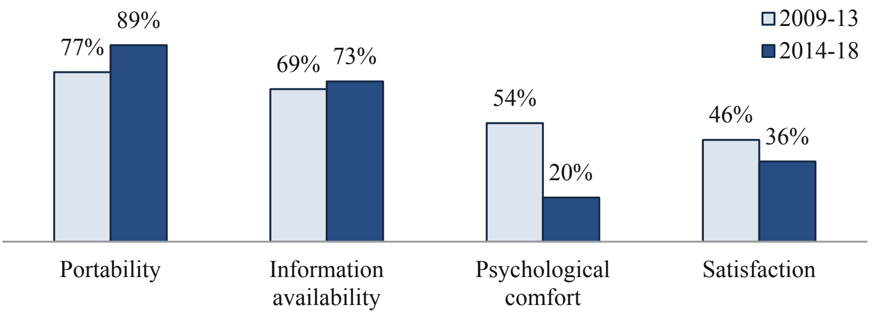

Fig. 6. Proportion of practices addressing the device usability

Figure 6 illustrates the proportion of practices addressing device usability. The "portability" of mobile devices affects the feasibility of using the devices in various locations and environments. This criterion was most frequently addressed in both periods. "Information availability" highlights the accessibility of information to enable just-in-time learning. About 70% of the practices in both periods addressed this criterion through proposing specific apps or evaluating whether mobile devices could retrieve resources from multi-sources. "Psychological comfort" refers to the elements that affect learners' cognitive load and efficiency in performing learning tasks, such as the speed to access resources, and the improvement in learners' confidence after using mobile devices. This criterion was less addressed in the second period, possibly as a result of the prevalence of mobile learning. "Satisfaction" refers to learners' enjoyment in using devices, which is highly personal and culturally determined. Most of the relevant practices simply addressed whether learners were happy with the devices for factors such as the devices' physical characteristics and functions.

4.6 Social Technology

The social technology covers the device and social aspects, focusing on how mobile devices enable information exchange and collaboration among learners and systems. It includes three criteria: (1) device networking, (2) system connectivity, and (3) collaboration tools.

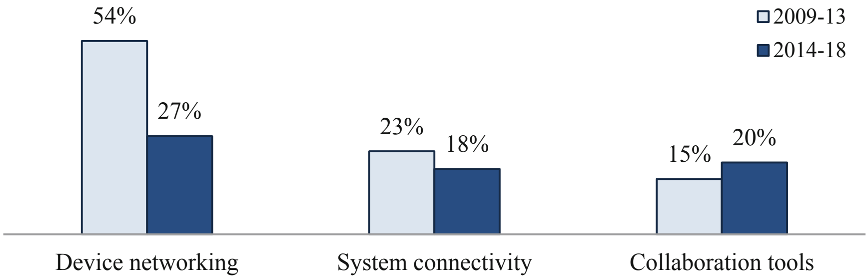

Fig. 7. Proportion of practices addressing the social technology

Figure 7 shows the proportion of practices addressing the social technology. "Device networking" refers to various types of network standards, such as WANs and WiFi, which allow learners to be connected with each other. The network issues were not a main concern anymore in the second period, as WiFi networks had become part of the basic facilities, especially in developed countries. "System connectivity" refers to the internet access and document transfer protocols. It stresses learners' convenience in exchanging information within and across systems. In both periods, about 20% of the practices addressed this criterion. But the practices in the second period focused more on the specific limitations of system connectivity, such as the need for certain software tools to access desired resources and synchronise information across platforms. "Collaboration tools" refers to the tools which support collaborative or shared tasks synchronously or asynchronously, such as co-authoring documents, coordinating tasks, and attending or providing lectures and demonstrations. The practices in the first period (15%) seldom addressed this criterion, possibly due to the limitations of network coverage. There were slightly more relevant practices in the second period (20%), such as conducting video-conferences and providing individual feedback to peer-learners.

4.7 Interaction Learning

The interaction learning covers the learner and social aspects, representing a synthesis of learning and instructional theories, together with the philosophy of social constructivism. It includes three criteria: (1) interaction, (2) situated cognition, and (3) learning communities.

Figure 8 presents the proportion of practices addressing interaction learning. The "interaction" between learners and others (learners and teachers) was most frequently addressed in both periods. While the practices in the first period were more about bringing mobile devices with preloaded contents to class for discussion or other tasks, those in the second period involved more sharing by students using online communication tools, and individualised feedback from teachers or peer-learners. "Learning communities" refers to a group of learners who work together towards mutual goals, such as entering into dialogue and problem-solving activities with other learners in different locations. Although about 30% of the practices in both periods addressed this criterion, those in the second period included more positive examples of creating learning communities to share and exchange knowledge, materials, and feedback in text or multimedia formats. "Situated cognition" refers to the percept that learning tasks should be situated within authentic contexts, such as having a real purpose and audience. This concept was rarely mentioned in the practices particularly in the second period, possibly because the advances in mobile technologies had allowed sharing information and feedback with others to become commonplace.

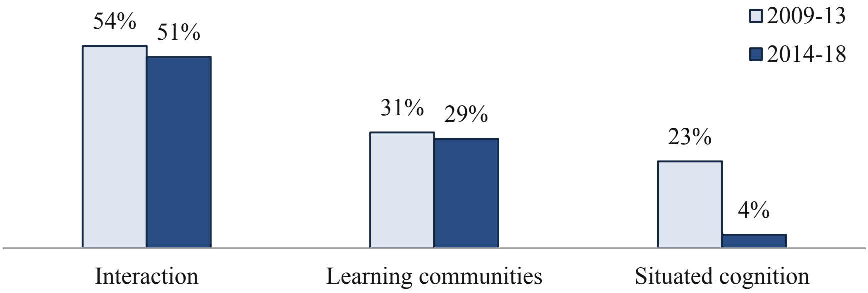

Fig. 8. Proportion of practices addressing the interaction learning

4.8 The Mobile Learning Process

According to the FRAME model, the mobile learning process is defined and continuously reshaped by the interaction between the device, learner, and social aspects (Koole 2009). Three criteria are included in this process: (1) mediation, (2) information access and selection, and (3) knowledge navigation.

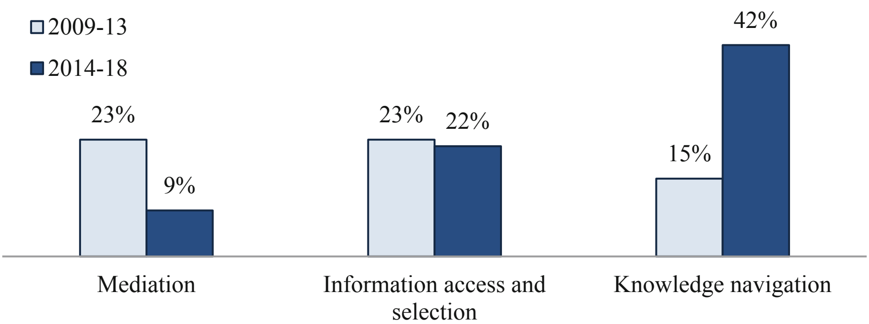

Fig. 9. Proportion of practices addressing the criteria related to the mobile learning process

Figure 9 shows the proportion of practices addressing the criteria related to the mobile learning process. “Mediation” is concerned with the changes of interaction as learners interact with each other, their environments and information with mobile devices. While only 23% of the practices addressed this criterion in the first period, those in the second period were even more infrequent (9%), possible because the changes were not apparent when the use of mobile devices for learning had become usual. “Information access and selection” is concerned with the rapid increase in the amount of information so that learners must make more effort to recognise and evaluate its appropriateness and accuracy, and avoid information noise. About 20% of the practices in both periods addressed this criterion. However, those in the first period involved more about accessing professional materials preloaded in the devices, such as reference books or flashcards, while those in the second period started to involve the evaluation and selection of suitable and authentic information from an enormous amount of data on the internet. “Knowledge navigation” stresses learner-centredness in mobile learning—that is, whether the learners can apply information to their unique situations and needs. Substantially more practices in the second period addressed this criterion. They stressed how the learning materials could be fitted to match the needs and learning practices of individual learners. Some practices also involved the provision of individualised help to students to meet their specific needs in learning.

5 Discussion and Conclusion

This study has identified the major patterns and trends of mobile learning in health-related disciplines published in the past decade. The findings echo the overall trends of mobile learning, viz. an increasing number and a broader range of countries/regions being involved in mobile learning research and practices (Hwang and Wu 2014). The study also revealed the features of the mobile learning practices with reference to the FRAME model, highlighting the areas which have been more commonly covered, such as the physical characteristics of devices and portability; learners’ ability to apply concepts and knowledge in varied contexts; and social interaction among learners and between learners and teachers. These areas are consistent with the findings of Chang et al. (2018) that mobile learning activities in nursing education have mainly involved guided learning through supplementary learning materials accessed from devices; synchronous sharing, discussion and joint problem-solving; and contextual learning in real-world environments.

Most mobile learning practices were conducted in developed countries, and those in developing countries have been emerging. With the improvement of network infrastructure, it is expected that the practices in developing countries will continually increase. Such a trend can also be seen in the substantially smaller proportion of practices (from 54% to 27%) addressing “device networking” in the second period. The readiness for mobile learning in a wider range of countries/regions allows more cooperation as a potential area for future work. Among the practices reviewed in the study, only one involved cross-country collaboration. To address the worldwide shortage of health professionals, mobile learning has been emphasised as a potential solution which allows efficient and cost-effective training with effectiveness comparable to conventional learning (Dunleavy et al. 2019). More cross-country collaboration in this area could support the development of health professional education in developing countries/regions and help to tackle the shortage of health professionals.

Between the two periods of time, some changes in the mobile learning practices have been shown to be driven by the public acceptance of the use of mobile devices. For example, the smaller proportion of practices addressing psychological comfort may be related to the changes in the perception of mobile learning. In the first period, nearly 40% of the practices mentioned learners' uncomfortable feelings about using mobile devices in clinical environments which may be perceived as unprofessional (Wittmann-Price et al. 2012). This percentage dropped to 9% in the second period, suggesting that the use of mobile devices had become more accepted by patients and clinical staff. Mann et al. (2015) raised the learners' and patients' concerns about the leaking of personal data and privacy. Zurmehly and Adams (2017) reported a school policy in Columbus that mobile phones are not allowed to be used in the classroom. These issues may affect learners' willingness to engage in mobile learning practices.

The mobile learning practices reviewed in this study showed different foci on the FRAME model. For example, there were practices involving mainly the provision or access of learning materials (e.g. Li et al. 2018) and the formulation of learning communities for collaborative learning (e.g. Lai and Wu 2016). While the FRAME model construes mobile learning as a process resulting from the device, learner and social aspects, Koole et al. (2018) explained that each aspect of the model is equally important. Nevertheless, some aspects of the model were less addressed in the practices, such as situated cognition in interaction learning, and mediation in the mobile learning process. Further work is needed to examine the factors affecting the design and implementation of mobile learning practices so as to understand the possible reasons for some aspects of the model being less addressed. Future studies may also investigate the practices in disciplines other than health-related ones in order to reveal their disciplinary differences, if any.

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Undergraduate Student's Acceptance of a Situational and Interactive Hotel English Learning APP: An Empirical Study Based on the Extension of UTAUT

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Abstract. With the development of information technology, smartphones have become an important channel of information acquisition, including classroom learning. Although information technology acceptance has been widely examined, research focusing on university students' acceptance toward adopting learning applications is limited. This study aims to identify determinants affecting students' technological acceptance of a Hotel English Learning APP based on the UTAUT model. Perceived entertainment and English self-efficacy were amended as antecedents of students' behavioral intention, apart from performance expectancy, effort expectancy, social influence, and facilitating conditions of UTAUT. The study gathered data from university students of Macao SAR, via a self-administered survey questionnaire. A total of 181 valid data were collected and analyzed using Partial Least Square (PLS) and SPSS. The results showed performance expectancy, effort expectancy, social influence, perceived entertainment, and English self-efficacy influence undergraduate students' intention toward using the English learning APP. Furthermore, the theoretical and practical contributions were also presented.

Keywords: User acceptance · English learning · UTAUT · Macao

1 Introduction

Technologies have been witnessed widely used in education. There are various English learning Applications available in the market. The diffusion of new technology in education and the realization of its potential advantages depend on students' acceptance and desire to use it [18]. It is extremely important for developers to understand the students' acceptance of the new technology. Moreover, when examining the use of a learning system, not only information systems (IS) usage behavior but also students learning behavior should be taken into consideration. Factors affect a student's acceptance of a learning application may different from the use of generic information systems. Therefore, students' acceptance to a learning application deserves extra attention.

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The Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. [16] has become one of the most superior and leading information systems theories of users' IT acceptance nowadays. Yet, it has only received limited validation in education, especially within the Macao SAR context. This research aimed to achieve a better understanding of the use of new technologies in the educational context. The determinants of university students' technology acceptance were examined. The purpose of this study was to assess undergraduate students' behavioral intention toward using a situational and interactive Hotel English learning APP in Macao.

2 Literature Review

2.1 The Unified Theory of Acceptance and Use of Technology (UTAUT)

Several models have been proposed to examine users' acceptance and intention to use information systems (IS). The UTAUT integrated eight IS acceptance models [16]. It has been widely examined and tested its technology acceptance and adoption prediction in various studies [4, 11, 13]. UTAUT explains 70% of the variance in user intentions to use technologies; it achieves a more comprehensive understanding of IS acceptance and outperforms previous IS acceptance models [16]. Therefore, UTAUT was utilized as a research framework to explain the undergraduate students' acceptance of the situational and interactive hotel English learning APP in this research.

There are four core determinants of users' behaviors intention in UTAUT, named performance expectancy, effort expectancy, social influence, and facilitating conditions. According to Venkatesh et al. [16], performance expectancy is the extent to which a user believes a technology will enhance job performance in performing certain activities; effort expectancy refers to the degree of ease associated with the use of the technology; social influence defines the extent to which the user perceives that the relevant people (e.g., family and friends) believe he or she should use the technology; and facilitating conditions describe the users' perceptions of the resources and supports available to use the technology.

2.2 APPs Used in English Learning

Abundant teaching tools have been developed to improve teaching and learning in classrooms. The young generation people grow up with the booming of digital technologies, prefer learning actively and dislike traditional lectures [8]. English learning APP, for example, *New Concept English*, mainly was designed to present teaching content and enable students to learn independently. There are also some specially designed APPs available, providing exercises in vocabulary, listening, or oral English. However, there is no specific software matches College English classroom teaching. The design and development of a college English learning APP to assist and promote university English teaching and learning is necessary.

APP learning was considered to be a seamless learning, which enables learners to gain information without time and space limitation [21]. With an English teaching

APP, students are allowed to access more diversified learning experiences out of the traditional classroom.

Moreover, many students suffer English anxiety when studying English. "Foreign Language Anxiety" [7, p. 1812] refers to the anxiety associated with learning a foreign language or communicate in the foreign language [5]. English anxiety generates a state of tension and nervousness, which has a negative influence on students' English learning. Students feel greater pressure and more anxiety in traditional classrooms when communicating with teachers [2]. Innovative information technologies enable students' self-learning and thus reduce English learning anxiety.

3 Methodology

3.1 The Situational and Interactive Hotel English Learning APP Introduction

In this study, a situational and interactive hotel English learning APP was proposed and tested (as shown in Fig. 1). The APP covers the English of hotel's major departments, such as Front Office Department, Housekeeping Department, Catering Department, Recreation Department, Shopping Center, and Security Department. There are several different scenes of English using in every hotel functional department. For example, the scenes include dinning in a restaurant, making reservation, cruise recommendation, and check-out. Students can also role-play as a customer or waiter/waitress in every situation to do English dialogues exercises.

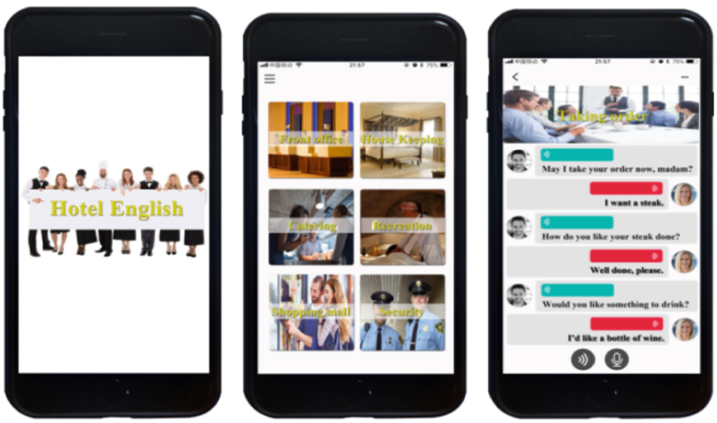


Fig. 1. Situational and interactive hotel English learning APP sample screens

3.2 Hypothesis Development and Research Model

Previous empirical studies proved that performance expectancy significantly affects the intention of using an IS [1, 10]. Researches also supported that the intention toward using an IS is significantly predicted by effort expectancy [1, 10, 17]. Moreover, previous studies confirmed that the intention of using an IS is significantly predicted by social influence [1, 10] and facilitating conditions [10, 16, 17].

Vallerand [14] presented a model of intrinsic and extrinsic motivation. Intrinsic motivation is driven by an interest or enjoyment in the task itself. Students with intrinsic motivation are more likely to be engaged in the task [20]. Entertainment means the interface is enjoyable, pleasant and exciting [12]. Entertainment is an important predictor of users' attitudes toward a website [9]. The entertainment perceived when using the English learning APP may strengthen students' intrinsic motivation and thus enhance their desire for acceptance and usage of the technology.

Self-efficacy was defined as the judgment of one's ability to accomplish tasks [3]. English self-efficacy was referred to students' perceived abilities in English language acquisition [19]. Students with a strong sense of English self-efficacy tend to make effort and willing to overcome the difficulty in learning English. Wang et al. [19] supported that English self-efficacy significantly predicts students' score improvements in medical English proficiency. Based on the literature, the following hypotheses were proposed:

H1: Performance expectancy (PE) has a positive influence on student's behavioral intention toward using a situational and interactive hotel English learning APP.
H2: Effort expectancy (EE) has a positive influence on student's behavioral intention toward using a situational and interactive hotel English learning APP.
H3: Social influence (SI) has a positive impact on student's behavioral intention toward using a situational and interactive hotel English learning APP.
H4: Facilitating conditions (FC) have a positive impact on student's behavioral intention toward using a situational and interactive hotel English learning APP.
H5: Perceived entertainment (PET) has a positive impact on student's behavioral intention toward using a situational and interactive hotel English learning APP.
H6: English Self-efficacy (SE) has a positive impact on student's behavioral intention toward using a situational and interactive hotel English learning APP.

In summary, this study tried to propose an extension to UTAUT to evaluate the acceptance of the situational and interactive hotel English learning APP. The theoretical model is shown in Fig. 2.

3.3 Measurement Items

All the measurements of the constructs were adapted from previous literatures with slight modifications to suit the English learning study. A 5-point Likert scale was used, ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire contained three sections. The first section was the instructions of the hotel English-learning APP proposed in this study. The second section measured respondent's perception of each construct in the conceptual model. The last section contained the demographic information of the respondents, such as gender, age, and the frequency of learning English. The reliability of the constructs was measured by Cronbach's alpha. To meet the acceptance level, the constructs' Cronbach's alpha should exceed 0.7 [6]. The reliability of the construct in this study ranged from 0.882 to 0.967 (shown in Table 1), which indicated the questionnaire of this study was highly reliable.

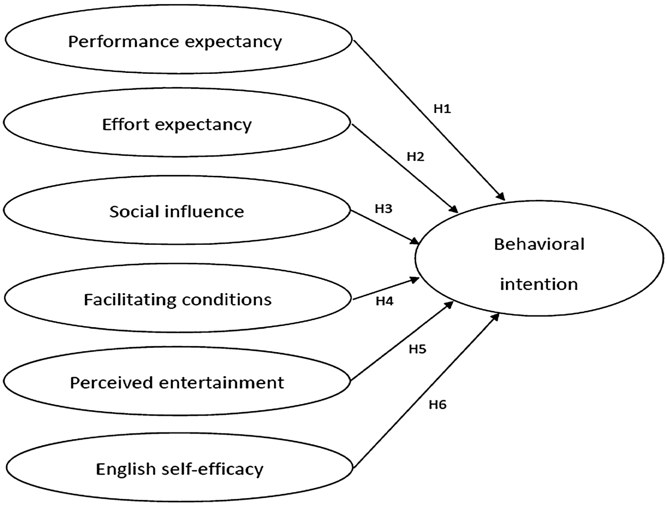


Fig. 2. The theoretical model

3.4 Sampling and Data Collection

The sample for this study was chosen from undergraduate students of Macao SAR. 200 students of the Faculty of International Tourism Management from different universities, including University of Macau, City University of Macau, and Macau University of Science and Technology, were selected. Researchers explained the features of the hotel English APP to respondents to ensure that the respondents have a good understanding of the APP before continuing the survey. Then, the self-administered survey questionnaire was utilized to assess the factors affecting students' behavioral intention toward using the English learning APP. Finally, a total of 181 valid data were collected and analyzed using Partial Least Square (PLS) and SPSS.

4 Results

Demographic characteristics of participants were surveyed using a demographic questionnaire. Participants in this study consisted of 200 college students in three Universities of Macao by the procedures described in the previous section. Finally, there were 181 valid data which could be used in this study. For these 181 students, 47.5% were male and 52.5% were female; 97.2% of the students were in the age group of 18–25; 42.5% of the students were sophomore; and 37.6% of them were senior students.

Cronbach's Alpha was used to assess the reliability of the measures used in this study. The results of the reliability analyses are presented in Table 1. The reliability of each measure was highly acceptable. In addition, the mean, standard deviation, and latent variable correlations are showed in Table 2. The correlations among these seven constructs are reasonable.

Table 1. Average Variance Extracted (AVE), Composite Reliability, and Cronbach's Alpha

	AVE	Composite reliability	Cronbach's Alpha
BI	0.946	0.972	0.943
EE	0.926	0.962	0.920
FC	0.808	0.927	0.882
PE	0.884	0.974	0.967
PET	0.905	0.950	0.895
SE	0.786	0.917	0.864
SI	0.931	0.964	0.926

Table 2. Descriptive statistic and latent variable correlations analysis

	Mean	SD	BI	EE	FC	PE	PET	SE	SI
BI	3.64	0.95	*0.973*						
EE	3.41	1.02	0.777	*0.962*					
FC	3.48	0.94	0.692	0.779	*0.899*				
PE	3.48	0.90	0.796	0.813	0.743	*0.940*			
PET	3.66	0.87	0.730	0.688	0.724	0.742	*0.951*		
SE	3.01	0.98	0.607	0.514	0.626	0.492	0.540	*0.887*	
SI	3.40	0.91	0.796	0.82	0.733	0.828	0.723	0.526	*0.965*

Table 3. Results of hypotheses testing

FACTOR → BI (Behavioral Intention)	Coefficient	p-value	
H1: Performance Expectancy → BI	0.271	0.007	Accept
H2: Effort Expectancy → BI	0.225	0.006	Accept
H3: Social Influence → BI	0.233	0.009	Accept
H4: Facilitating Conditions → BI	–0.114	0.158	Reject
H5: Perceived entertainment → BI	0.173	0.020	Accept
H6: English self-efficacy → BI	0.241	0.000	Accept

The bootstrapping analysis in Smart PLS programme was performed to assess the significance of the path coefficients among these six constructs. The results of the PLS analysis are shown in Fig. 3. The results of hypotheses testing are presented in Table 3. Accordingly, the final model is shown in Fig. 4.

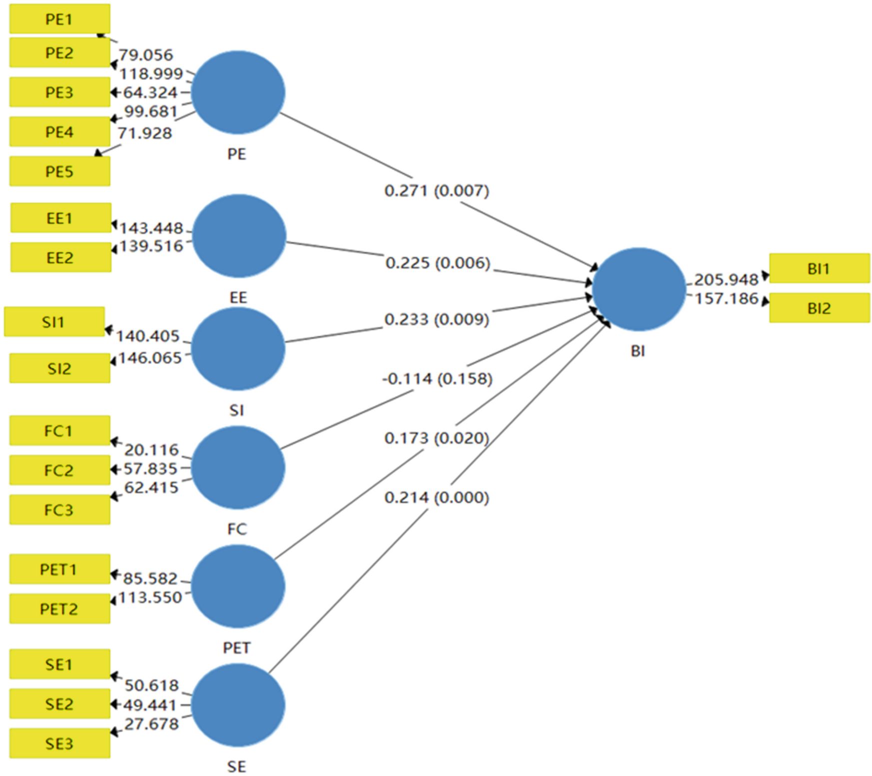
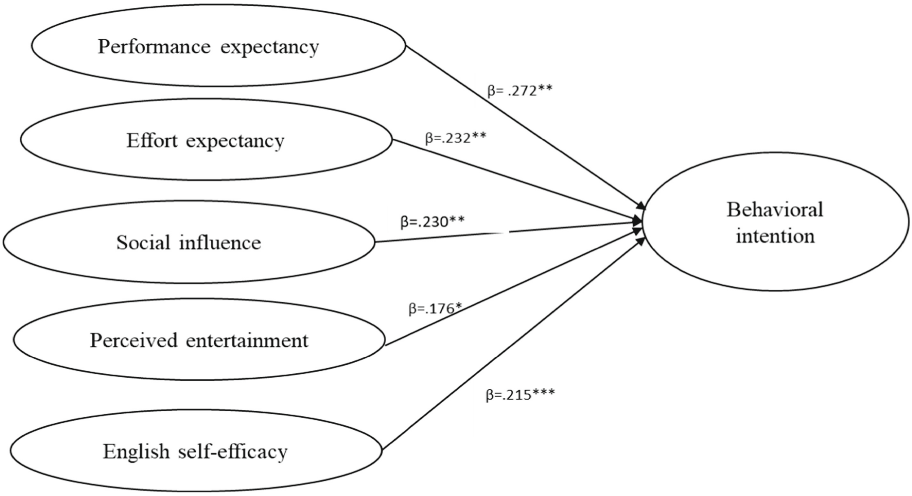


Fig. 3. The results of PLS analysis



Note: **p*<0.05, ***p*<0.01, ****p*<0.001

Fig. 4. Final model

5 Conclusion

Using PLS with valid data provided by 181 college students from three Macao universities, the paper examined that performance expectancy, effort expectancy, social influence, perceived entertainment, and English self-efficacy have an important influence on student's behavioral intention. However, there is no significant relationship between facilitating conditions and students' behavioral intention toward using the hotel English learning APP.

5.1 Discussion

According to the PLS analysis ($R^2 = 0.753$), the final model was established. By testing the UTAUT model, the findings supported the earlier studies [7, 10]. It confirmed the importance of performance expectancy, effort expectancy, and social influence to behavioral intention. But the factor of facilitating conditions was unexpected of not having a significant influence on college student' intention toward using a hotel English learning APP. This result was contrary to the findings of prior researches [10, 16, 17]. This could result from the limitations of the UTAUT's applicability in different user populations and its levels of voluntariness. This means that facilitating conditions might have less consideration among the college students in Macao. In addition, effort expectancy could moderate the relationship between facilitating conditions and behavioral intention [15], that may be another explanation for the insignificance relationship between facilitating conditions and behavioral intention. Moreover, the findings of the study further indicated the importance of perceived entertainment and English self-efficacy to behavioral intention, which also supported the prior studies [9, 19]. It showed that both perceived entertainment and English self-efficacy are important predictors to college students' intention toward using a hotel English learning APP.

5.2 Implications

This study supported the literature on how targets of behavioral intention in college students setting respond to technology, and empirically validated the UTAUT model by going a step further to explore its applicability in an educational setting. The findings of this study confirmed the importance of performance expectancy, effort expectancy, social influence, perceived entertainment, and English self-efficacy in determining the undergraduate students' English learning behavioral intention in Macao. From a research perspective, this study contributed to the existing literature by investigating these relationships. From a practical perspective, by extending the UTAUT model, the study aimed to investigate the undergraduate students' behavioral intention to accept the situational and interactive hotel English learning APP at Macao's universities, this study provided a solution to solve the anxiety of English study, especially for college students. Thus, this research contributed to the development of UTAUT in the domain of education. The results enabled developers to become more knowledgeable about the psychological factors that encourage students to use the English learning APP. The research substantially contributed to the design and development of the Hotel English learning APP. And that also gave a strong reference to develop related English study APP.

5.3 Limitations

There are several limitations to the research. First, the sample was limited to Macao undergraduate students, which might affect the generalization of the results. Future studies may consider collecting data from diverse regions. Second, two constructs were chosen to extend the UTAUT and investigate students' intentions toward using the hotel English APP, but there might be other potential constructs (e.g., perceived quality, flexibility) that might affect students' behavior intention. In future studies, researchers may propose alternative models to examine the determinants of users' behavioral intention toward using the hotel English APP.

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Students' Use Intention and Behavior Toward Knowledge Forum: A Survey Study from the Perspective of Diffusion of Innovation Theory

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Abstract. Numerous studies have been conducted on knowledge forum (KF), however, the majority of these studies are on the application of KF. Few studies investigated the factors that affect the wide use of knowledge forum from the perspective of Diffusion of Innovation Theory (DIT). The aim of this study is to investigate students' use intention and behavior on knowledge forum using DIT and extended Technology Acceptance Model (TAM). An online survey was administered to a sample of 150 students who had been using the knowledge forum. Exploratory factor analysis using Amos was utilized to examine the fitness and the construct validity of the research model. Structural equation modeling (SEM) was adopted to examine whether the factor loadings for the 8 elements were significant and whether the estimates for each of them were in a reasonable range. The research findings have implications for the development, management, and spread of KF in practice.

Keywords: Knowledge forum · Knowledge building · Use intention · Diffusion of innovation theory

1 Introduction

According to Bereiter and Scardamalia (2003), knowledge building (KB) can be simply defined as "creative work with ideas that really matter to the people doing the work" (p. 13). As a type of constructivist approach, KB shares many characteristics with other constructivist approaches (Bereiter and Scardamalia 2003), there are, however, quite a few important differences between these two concepts (Bereiter and Scardamalia 2003). However, the comparison of constructivism and KB is not in the scope of this study, an excellent account can be found in Scardamalia (2002). While for the purpose of this research study, the authors feel it necessary to point out a very distinct difference between constructivism and KB which will be presented in the following text. In "psychological constructivism" as proposed by Piaget (1952, 1957) and his school, KB is usually regarded as an internal process, which takes place spontaneously and without

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learners' awareness (Bereiter and Scardamalia 2014). While in strong contract to the constructivism (Piaget 1952, 1957), KB is "a type of deliberate, conscious action, which produces knowledge that has a public life" (Bereiter and Scardamalia 2014, p. 35).

As discussed above, KB is a process in which a series of conscious actions with the aim of knowledge creation could be observed. How to visualize the process remained a serious issue for KB scholars until the emergence of "Computer Supported Intentional Learning Environments (CSILE)" that resulted from the research on knowledge building, on the nature of expertise, and on the socio-cultured dynamics of innovation (Scardamalia 2003). Basically, CSILE is a networked system in which the students have access to a database comprised of texts and graphical notes produced by students themselves, and they could comment on each other's contributions (Scardamalia and Bereiter 1991). The focus on the creation of student-generated community is the most distinctive feature of CSILE (Scardamalia et al. 1989). With the empowerment of technologies over the years, CSILE has been renamed as "knowledge forum" and it is currently in version 4.8 with version 5.0 under development.

Basically, to the best knowledge of the researchers, the majority of existing studies used knowledge forum as a tool to support KB (Aalst et al. 2017; Hong et al. 2015; Lee et al. 2006; Zhang et al. 2009), which was the original intention of developing knowledge forum (Bereiter and Scardamalia 2003; Scardamalia 2002, 2003; Scardamalia and Bereiter 1991, 2003). However, there are few studies exploring the factors impacting users' acceptance of knowledge forum, and even fewer studies investigated this issue from the perspective of diffusion of innovation theory. TAM developed by Davis and colleagues (1989) has been the most influential model to investigate users' acceptance of technology (Cheng 2019; Sivo 2018; Yang and Kwok 2017). In this study, a research model was constructed based on the TAM (Davis 1989; Davis et al. 1989) and the five key elements in the DIT (Rogers 2003).

The rest of the study is organized as follow. Section 2 presents the review of literature relevant to this study. Section 3 introduces the research methodology used in this study which includes research model and data collection. Section 4 reports the data analysis and results. Conclusions are given in Sect. 5.

2 Related Literature

2.1 Knowledge Forum

As a system that supports collaborative learning (Scardamalia and Bereiter 2006; Scardamalia et al. 1989; Tan and Seah 2011; Zhang et al. 2009), knowledge forum has been used in numerous studies. To name a few, Tan and Seah (2011) explored elementary students' questioning behaviors using knowledge forum, the findings indicated that students tended to ask only scientific questions when presented with close-ended task. Zhang et al. (2009) constructed a KB community based on knowledge forum with the aim of increasing 4th grade students' level of collective responsibility. The students were assigned into three different groups: (1) fixed small groups; (2) interacting small groups with knowledge sharing among groups; (3) opportunistic collaboration groups. The findings suggested that the students in the third group assumed the highest level of collective cognitive responsibility (Zhang et al. 2009). In their study of examining collaborative knowledge building, Lee et al. (2006) designated three classes of 9th grade students into different groups in which group 1 students only used knowledge forum, group 2 students used knowledge forum with portfolios, and group 3 students used knowledge forum with portfolios and principles. The findings showed that students working on portfolios gained deeper inquiry and more conceptual understanding than their peers, students' conversations on KB contributed to their domain understanding, and the KB portfolios helped assess and foster collective knowledge advances (Lee et al. 2006). To explore the use of principle-based tools on the improvement of community KB in 5th/6th students, Hong, Scardamalia, Messina, and Teo (2015) used three analytic tools which were built into knowledge forum. The data were collected from the discourse generated by students which were stored in knowledge forum over a school semester. The findings suggested positive effect on students' use of key terms and productive vocabulary (Hong et al. 2015).

2.2 Diffusion of Innovation Theory

As one of the most popular and influential theories in social science, the DIT proposed by Rogers serves as the theoretical foundation for the exploration of the adoption of information and communication technologies (ICT) and the understanding of the way ICT innovations spread in the population (Rogers 2003). As defined by Rogers (2003), innovation is "*an idea, practice, or object that is perceived as new by an individual or other unit of adoption* (p. 47)." While diffusion is "*the process in which an innovation is communicated through certain channels over time among the members of a social system* (p. 40)."

There are five user-perceived attributes that could determine the success of an innovation, which are relative advantage, compatibility, complexity, trialability, and observability (Rogers 2003). Relative advantage is the degree to which an innovation is perceived as better than the existing technologies, and the greater the perceived relative advantage of an innovation, the sooner the innovation will be adopted (Rogers 2003). Compatibility refers to the extent to which an innovation complies with the standards of existing technological and social environment. The more an innovation is compatible with existing values, norms or practice, the more easily it will be adopted (Rogers 2003). Complexity measures the degree to which an innovation is perceived as difficult to understand, implement or use. An innovation that are simpler to understand will be more rapidly adopted than the one that requires enormous amount of mental efforts from adopters (Rogers 2003). Trialability is the ability of an innovation to be experimented with limited commitment and investment. An innovation that has a higher trialability could be adopted more easily and rapidly (Rogers 2003). Observability refers to the extent to which the benefits of an innovation could be observed by potential adopters. Visible results from an innovation mean lower uncertainty, which could motivate potential adopters to more easily accept it (Rogers 2003).

Throughout the years, DIT has been used in numerous studies to investigate individuals' or organizations' adoption of new information and communication technologies (Helitzer et al. 2003; Moore and Benbasat 1996; Mustonen-Ollila and Lyytinen 2003; Norton and Bass 1987). For instance, in their longitudinal study over a period of four years, Mustonen-Ollila and Lyytinen (2003) applied the DIT to identify the factors that affect the adoption decision of more than 200 information system process innovations in three organizations. Helitzer et al. (2003) investigated the factors affecting the adoption of telehealth system using the DIT in rural areas of New Mexico. Moore and Benbasat (1996) explored the adoption of an information technology by users from the perspective of DIT and theory of reasoned action. The results revealed that complexity, relative advantage, and compatibility as proposed in the DIT yielded significant effect on the degree of the use of information technology (Moore and Benbasat 1996).

2.3 Technology Acceptance Model

TAM (Davis 1989; Davis et al. 1989) is rooted in the theory of reasoned action (Fishbein and Ajzen 1975), which aims to investigate how users perceive and use technology by exploring the relationships between perceived usefulness (PU), perceived ease of use (PEU), and attitude towards technology use (Yang and Kwok 2017). PU is defined as "the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context" (Davis et al. 1989, p. 985), which aligns with the definition of "relative advantage" in DIT as introduced in the review of literature. PEU is referred to as "the degree to which the prospective user expects the target system to be free of effort" (Davis et al. 1989, p. 985), which echoes with the definition of "complexity" as proposed in DIT. TAM posits that PU and PEU have direct influence on users' attitude toward technology use (Davis et al. 1989; Venkatesh and Davis 1996), and it has been validated in many studies (Camarero et al. 2012; Deng et al. 2005; Elyazgi et al. 2016; Shroff et al. 2011; Zacharis 2012).

3 Research Methodology

3.1 Research Model and Hypotheses

The following Fig. 1 illustrates the research model of this study. This model, adapted from TAM (Davis 1989; Davis et al. 1989), was constructed to investigate the factors influencing students' acceptance of knowledge forum from the perspective of DIT (Rogers 2003). The five key elements: relative advantage, compatibility, complexity, trialability, and observability from DIT (Rogers 2003) and user attitude, behavioral intention, and use behavior from TAM (Davis 1989; Davis et al. 1989) comprise the main constructs of the research model. As described in the "Technology acceptance model" section, the definitions of PU and PEU in the TAM are similar with the definitions of relative advantage and complexity in DIT, and due to the exploratory nature of this study, the authors did not include PU and PEU in the model. DIT posited that (1) the greater the perceived relative advantage of an innovation, the sooner the innovation will be adopted; (2) the more an innovation is compatible with existing values, norms or practice, the more easily it will be adopted; (3) an innovation that is simpler to understand will be more rapidly adopted than the one that requires enormous amount of mental efforts from adopters; (4) an innovation that has a higher trialability could be adopted more easily and rapidly; (5) visible results from an innovation mean lower uncertainty, which could motivate potential adopters to more easily accept it. And TAM advocated that (1) PEU (complexity in this study) can predict PU (relative advantage in this study); (2) both PU and PEU can determine users' attitude towards technology; and (3) PU and attitude towards technology can affect behavioral intention to use technology. All these possible associations were transformed into the following hypotheses for further investigation in this study:

H1. Relative advantage of KF has a positive effect on behavioral intention.
H2. Trialability of KF has a positive effect on users' attitude.
H3. Observability of KF has a positive effect on users' attitude.
H4. Relative advantage of KF has a positive effect on users' attitude.
H5. Complexity of KF has a positive effect on relative advantage.
H6. Compatibility of KF has a positive effect on relative advantage.
H7. Complexity of KF has a positive effect on users' attitude.
H8. Compatibility of KF has a positive effect on users' attitude.
H9. Users' attitude toward KF has a positive effect on behavioral intention.
H10. Behavioral intention to use KF has a positive effect on actual using behavior.

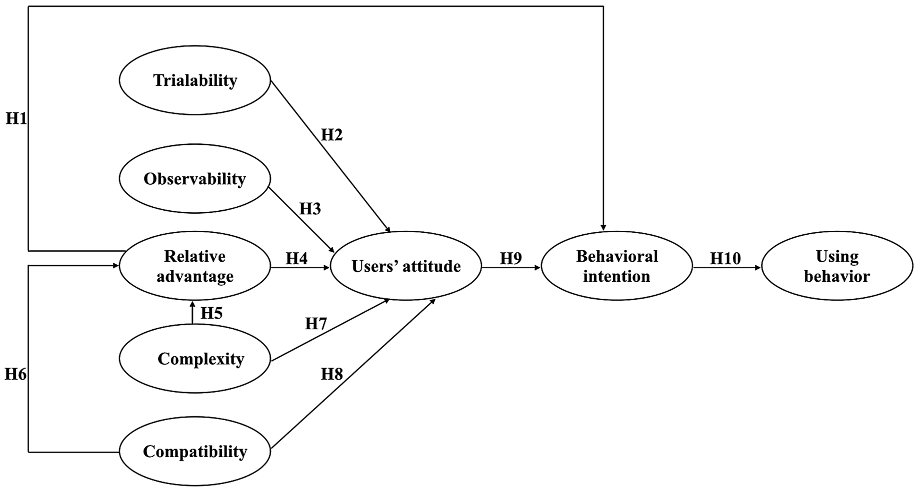

Fig. 1. The research model of this study

3.2 Data Collection and Sampling

An online survey composed of 26 items (i.e., 3 items for the construct of relative advantage, 3 for observability, 3 for trialability, 3 for complexity, 3 for compatibility, 5 for users' attitude, 3 for behavioral intention, and 3 for actual using behavior) was administered to about 500 users who had been using KF at a university in northern China. These users voluntarily participated in the survey which guaranteed the random selection of research subjects. One hundred and fifty users filled out the survey, among which 113 surveys were valid and entered the analysis pool in this study after data cleaning. There were 52 male users and the average duration all the users spent on KF per week was approximately 6.1 h.

4 Data Analysis and Results

4.1 Reliability

The coefficient of reliability of each construct was assessed using Cronbach's alpha. A Cronbach's alpha value of .70 is considered acceptable as recommended by DeVellis (2016). The overall Cronbach's alpha value is .9143, and the value of each construct is well above the threshold value (.70), suggesting that all the constructs in this survey exhibited high internal consistencies.

4.2 Construct Validity

To test the construct validity of the items in the survey, exploratory factor analysis was performed using Amos for Windows. Some items were set to "fixed factor", therefore, these items did not have corresponding values of standard error (S.E.) and critical ration (C.R.). As shown in Table 1, all values of factor loading were well above the threshold value (.50), indicating that the survey has good construct validity (Chin 1998).

Table 1. Construct validity for the constructs of the measurement model

Constructs	Items	S.E.	C.R.	Factor loading
Trialability (T)	T1			.667
	T2	.110	8.887	.679
	T3	.132	8.853	.683
Observability (O)	O1			.611
	O2	.144	8.112	.701
	O3	.145	8.215	.683
Relative advantage (RA)	RA1	.112	7.556	.574
	RA2	.104	8.897	.653
	RA3			.653
Complexity (C)	C1	.132	8.329	.709
	C2	.147	8.801	.842
	C3			.734
Compatibility (CP)	CP1			.533
	CP2	.192	5.352	.659
	CP3	.214	5.281	.687

(*continued*)

Table 1. (*continued*)

Constructs	Items	S.E.	C.R.	Factor loading
User attitude (UA)	UA1	.121	8.132	.601
	UA2	.101	8.749	.670
	UA3			.712
	UA4	.123	8.436	.699
	UA5	.112	8.157	.668
Behavioral intention (BI)	BI1	.104	9.117	.725
	BI2	.117	8.854	.696
	BI3			.643
Using behavior (UB)	UB1	.184	7.852	.614
	UB2	.199	4.956	.709
	UB3			.666

4.3 Structural Equation Modeling

This section discusses the results of the modeling testing. To evaluate the math between the data and the model, χ^2, df, the root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker–Lewis index (TLI) were used as indexes of goodness-of-fit (Barrett 2007; Hu and Bentler 1999; Kenny 2014). The ratio of χ^2 to its df was used since χ^2 was sensitive to sample size. The ration value below 3 was considered acceptable (Barrett 2007; Hu and Bentler 1999; Kenny 2014). Ideally, the value of RMSEA should be less than .08, and the values of CFI and TLI should be above .9 (Barrett 2007; Hu and Bentler 1999; Kenny 2014). The satisfaction of these values represents a good model fit. Table 2 shows the coefficients of the model fit.

As shown in Table 2, the TLI value was below .90. Therefore, a modification of the model should be conducted. Since the path from compatibility to users' attitude was not significant with a p = .328 > .05 (the detailed result is presented in Table 4), this path was deleted for further model fitting test. The coefficients of the model fit was shown in Table 3, the evaluation results of the model were presented in Table 4, and the path coefficients of the research model were illustrated in Fig. 2.

Table 2. Coefficients of model fit

χ^2	df	χ^2/df	RMSEA	TLI	CFI
548.233	289	1.897	.061	.897	.901

Table 3. Modified coefficients of model fit

χ^2	df	χ^2/df	RMSEA	TLI	CFI
464.290	290	1.601	.048	.937	.925

Table 4. Evaluation results of the structural model

Hypothesis	Path	Estimate	S.E.	C.R.	*p*	Hypothesis supported?
H1	RA → UA	.313	.101	3.132	***	Yes
H2	T → UA	.697	.128	5.740	***	Yes
H3	O → UA	.891	.225	3.613	***	Yes
H4	RA → UA	.835	.077	4.374	***	Yes
H5	C → RA	.387	.098	3.153	***	Yes
H6	CP → RA	.692	.147	4.509	***	Yes
H7	C → UA	.724	.135	5.197	***	Yes
H8	CP → UA	.091	.069	1.303	.328	No
H9	UA → BI	.228	.107	2.136	***	Yes
H10	BI → UB	.741	.152	4.693	***	Yes

***$p < .001$

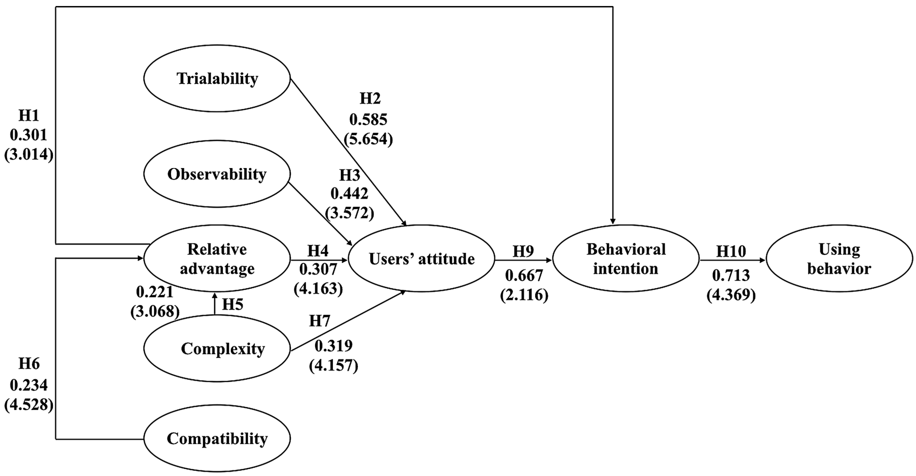

Fig. 2. Path coefficients of the research model

5 Conclusion

There have been limited research into the acceptance of KF from the perspective of DIT. To address this research gap, this study constructed a research model based on TAM and DIT to investigate the factors influencing users' acceptance of KF. The findings indicated that: (1) the relative advantage of KF has a positive effect on behavioral intention; (2) the trialability of KF has a positive effect on users' attitude; (3) the observability of KF has a positive effect on users' attitude; (4) the relative advantage of KF has a positive effect on users' attitude; (5) the complexity of KF Relative advantage of KF has a positive effect on relative advantage; (6) the compatibility of KF Relative advantage of KF has a positive effect on relative advantage; (7) the complexity of KF Relative advantage of KF has a positive effect on users' attitude; (8) the compatibility of KF Relative advantage of KF does not have a positive effect on users' attitude; (9) users' attitude toward KF has a positive effect on behavioral intention; (10) behavioral intention to use KF has a positive effect on actual using behavior.

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A Review on the Admission Policies of Hong Kong Universities for Non-local Students from Mainland China

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Abstract. Students from Mainland China are the largest group of non-local students for Hong Kong universities in recent years. To attract more Mainland students and smoothen their application processes, the admission policies of Hong Kong universities are becoming increasingly more compatible for students from Mainland by recognizing various qualifications and standard examinations (e.g., Joint Entrance Exam For Universities in PRC, College English Test and Test for English Majors). However, the quick increasing amount of Mainland students in Hong Kong universities has brought various social issues concerning arguments about the medium of instructions, Hong Kong-mainland contradictions and so on. To understand how the various policy text, this essay reviews the admission policies of Hong Kong universities and related issues from three aspects: institution categories, programme levels, and place of origin. Furthermore, research questions such as what broader politics surround the policy issue, which institutions/actors are involved in the policy process and what the outcomes are answered by employing the political system theories. The social problems related to the admission policies will be examined and discussed, solutions for which will also be proposed.

Keywords: Hong Kong universities · Admission policies · Non-local students · Mainland students

1 Introduction

Students from Mainland China are the largest group of non-local students for Hong Kong universities in recent years. As shown in Table 1, the total headcounts of non-local students in programmes funded by the university grants committee (UGC) at

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Hong Kong are 15151 and 15727 (16% of the total numbers of students) in the academic years 2014/15 and 2015/16 respectively. The total headcounts of students from the Mainland are 11610 and 11891 (77% and 76% of the total numbers of non-local students) in the academic years 2014/15 and 2015/16 respectively. One of the reasons for such a big proportion of mainland students in HK universities is that the admission policies of Hong Kong universities are becoming increasingly more compatible for Mainland students by recognizing various qualifications and standard examinations. Such policies play great roles in attracting more Mainland students and smoothening their application processes.

Table 1. Non-local students enrolment in UGC-funded programmes by place of origin ("Non-local Student Enrolment" 2017)

Academic year/place of origin					
	2014/15				
	The Mainland of China	Other Places in Asia	The rest of the World	Total	As % of Total no. of students
Total	11610	2831	710	15151	16%
	2015/16				
	The Mainland of China	Other Places in Asia	The rest of the World	Total	As % of Total no. of students
Total	11891	3130	706	15727	16%

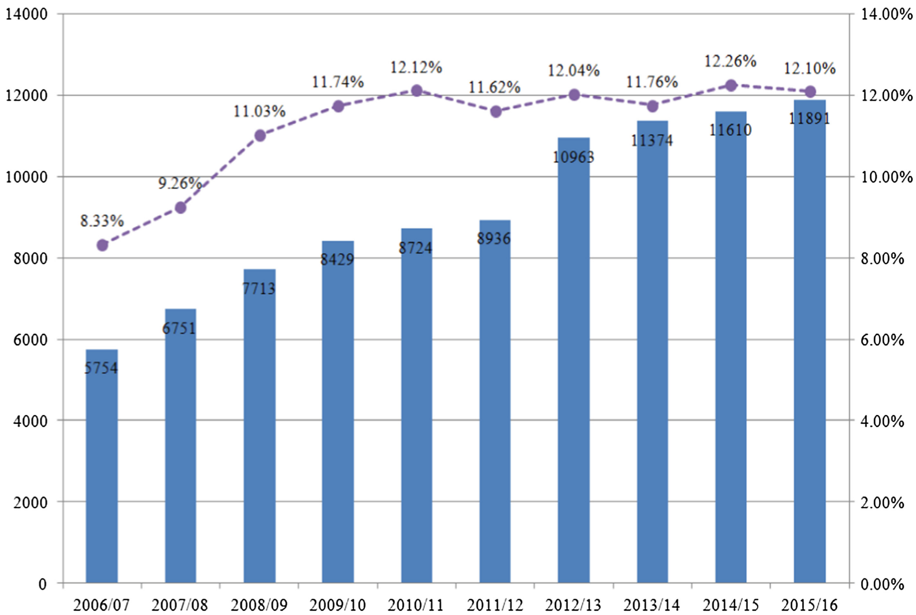

Fig. 1. The numbers and percentages of Mainland students in UGC-funded programmes in the past ten years ("Non-local Student Enrolment" 2017)

For example, all Hong Kong universities accept the results of the Joint Entrance Exam (JEE) For Universities in PRC as the single admission requirement for their undergraduate programmes. Some universities such as the City University of Hong Kong and The Chinese University of Hong Kong have obtained the approval from the Ministry of Education in China to directly recruit Mainland students in a dedicated batch before the recruitment of China universities ("Mainland Student Admission" 2017). The language requirements (i.e., English) are also adapted to a threshold of English subject scores in the JEE plus with an English interview. The College English Test Band 6 (CET 6), a very common standard English test used in Mainland universities ("College English Test" 2017), has also been considered as an English proficiency requirement equivalent to the International English Language Testing System (IELTS) or the Test of English as a Foreign Language (TOEFL) for postgraduate programmes. Similar to CET-6, Test for English Majors Band 8 (TEM 8), a standard test for English major students in Mainland universities ("Test for English Majors" 2017), has become a recognized English test for admission to the postgraduate programmes related to English Education or Linguistics.

The adaption of admission policies to Mainland educational systems bring about the increasing numbers of Mainland students in the past ten years. As shown in Fig. 1, the number of mainland students was 5274 (8.33%) in the academic year 2006/07, while it became 11891 (12.10%) in the academic year 2015/16[1]. However, the sharp increasing amount of Mainland students in Hong Kong universities has brought some social issues including arguments about the medium of instructions, the occupation of university resources and so on. Therefore, the main contributions of this essay are as follows.

- To understand how the various policy text, the admission policies of Hong Kong universities will be reviewed within a framework from three dimensions: institution categories, programme levels and place of origins;
- Research questions such as what wider politics surround the policy issue, which institutions/actors are involved in the policy process and what the outcomes are answered by employing the political system theories;
- The related social issues and problems caused by admission policies of Hong Kong universities will be discussed and investigated;
- The possible solutions to the problems concerning the admission policies of Hong Kong universities and improvements will be proposed.

The remaining parts of this essay will be organized as follows. Section 2 will examine the admission policies of Hong Kong universities using the three-dimensional framework. Section 3 will adopt political system theories to analyze admission policies. Section 4 will discuss related social issues caused by the admission policies, real examples of which will also be analyzed. And the possible solutions to these problems will be suggested in Sect. 5. The last section will summarize the whole essay and discuss some future research directions.

[1] The statistical data is only for the UGC-funded programmes, while the number of Mainland students will be much larger in self-finance programmes.

2 The Three-Dimensional Framework for Admission Policies

In this section, the admission policies of Hong Kong universities will be reviewed from three dimensions: institution categories, programme levels and place of origins. The institution categories are determined by the main funding sources of the universities/institutions (i.e., UGC-funded and self-financed institutions). The programme levels refer to different levels of programmes (i.e., undergraduates and postgraduate programmes). The place of origins is the different countries/regions of non-local students (i.e., Mainland students and other non-local students). As such, a three-dimensional framework for admission policies is established (see Fig. 2), based on which, the admission policies of Hong Kong universities will be elaborated in the following subsections.

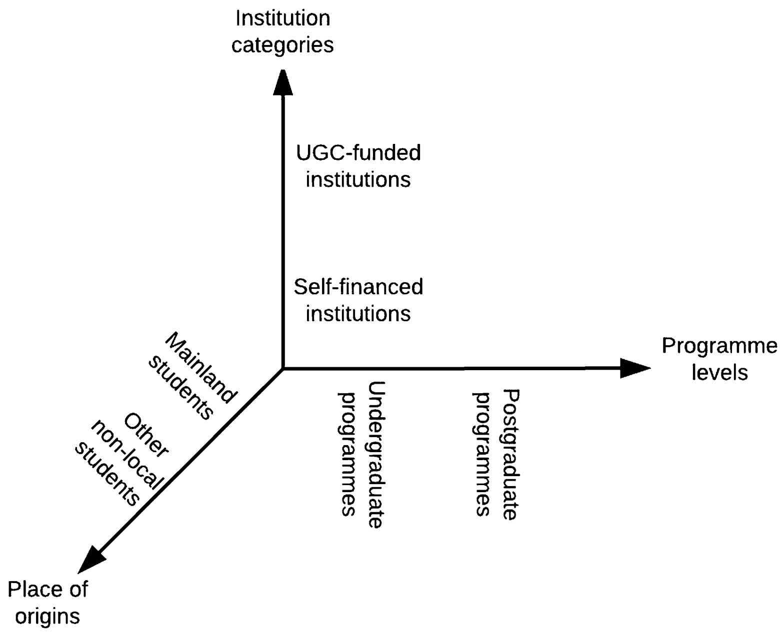

Fig. 2. The three-dimensional framework for admission policies of Hong Kong universities

2.1 Institution Categories

There are mainly two categories of institutions for higher education, which are UGC-funded intuitions (or universities) and self-financed institutions (or universities) as shown in Table 2. The admission policies in these two categories of institutions are different as the fund bodies and/or the education bureau normally give them different guidelines. For example, the education bureau has sent guidelines to 8 newly-established self-financed institutions (e.g., Hang Seng Management College and Caritas Institute of Higher Education) to cease their recruitment of Mainland students until they obtained formal approvals from the Education Ministry of China on 5 Nov, 2015 ("Hong Kong Hang Seng College" 2017). However, several self-financed institutions including The Open University of Hong Kong, Hong Kong Shue Yan University and Chu Hai College of Higher Education are allowed to recruit Mainland students as they have obtained approvals from the ministry of education of China.

Table 2. The list of UGC-funded and self-financed universities/institutions at Hong Kong ("Hong Kong degree-awarding" 2017)

UGC-funded universities/institutions	Self-financed universities/institutions
-City University of Hong Kong -Hong Kong Baptist University -Lingnan University -The Chinese University of Hong Kong -The Education University of Hong Kong -The Hong Kong Polytechnic University -The Hong Kong University of Science and Technology -The University of Hong Kong	-Caritas Institute of Higher Education -Centennial College Centennial College -Chu Hai College of Higher Education -Gratia Christian College -Hang Seng Management College -HKCT Institute of Higher Education -Hong Kong Nang Yan College of Higher Education -Hong Kong Shue Yan University -Tung Wah College -Technological and Higher Education Institute of Hong Kong -The Open University of Hong Kong

- The admission policies of these two categories of universities are basically similar. They both accept the JEE (Joint Entrance Exam) results as the main admission requirements for undergraduate programmes. The JEE English subject results, an interview and/or a written test are considered as the main approaches to measuring English proficiency levels. For postgraduate programmes, they accept the bachelor degree from Mainland universities and CET as the English proficiency requirements. The differences in the admission policies of UGC-funded universities and self-financed educational organizations are as follows.
- The UGC-funded institutions normally have higher admission requirements than self-financed institutions. For example, City University of Hong Kong normally requires more than 600 out of 750 in JEE scores, while The Open University of Hong Kong requires about 480 out of 750. Normally, the required JEE scores for UGC-funded institutions at Hong Kong are equivalent to the 1st tier universities in Mainland China, while the required JEE scores for self-financed institutions at Hong Kong are equivalent to the 2nd tier universities in Mainland China.
- The UGC-funded institutions usually require more expensive tuition fee than self-financed institutions. The City University of Hong Kong requires 120,000 HK dollars per annum for non-local undergraduate programmes, while Chu Hai College of Higher Education requires 60,000 to 70,000 HK dollars per annum. One reason is that the human cost of UGC-funded institutions is higher than self-financed institutions.

2.2 Programme Levels

From the perspective of programme levels, the admission policies can be summarized as shown in Table 3. For undergraduate programmes, the JEE and JEE English subject scores are regarded as the general admission requirements and English proficiency requirements for Mainland students. For postgraduate programmes, a bachelor degree from Mainland universities and a passing score of CET test will be adequate for Mainland students.

Table 3. The admission requirements of different levels of programmes for Mainland students

	Undergraduate programmes	Postgraduate programmes
General admission requirements	• A threshold for JEE	• A bachelor degree in a related field
English proficiency requirements	• A threshold for JEE English subject • An interview	• A threshold for CET • An interview

However, the requirements of Hong Kong universities may be quite different. For example, to get an offer from the City University of Hong Kong, students normally need CET-6 scores higher than 425 out of 700, while The Chu Hai College of Higher Education requires about 425 out of 700 in CET-4 scores. In addition, some UGC-funded universities such as The University of Hong Kong only accept IELTS or TOFEL as the English proficiency requirements for their postgraduate programmes (Table 4).

Table 4. The admission requirements for other non-local students

	Undergraduate programmes	Postgraduate programmes
General admission requirements	• GCE or IB	• A bachelor degree in a related field
English proficiency requirements	• TOFEL, IELTS or other local equivalent qualifications • An interview	• Not necessary for English speaking countries • TOFEL, IELTS or other equivalent qualifications

2.3 Place of Origins

Compared to the admission policies for Mainland students, Hong Kong universities also have comprehensive admission policies for non-local students from other places. Basically, General Certificate of Education (GCE) System and International Baccalaureate (IB) Diploma are used as general admission requirements, and TOFEL, IELTS and other local equivalent qualifications are adopted as English proficiency requirements for undergraduate programmes. A bachelor degree in a related field is sufficient for postgraduate programmes if the applicant is from the English-speaking countries. Otherwise, TOFEL or IELTS is necessary for English proficiency requirements.

3 Analyzing Admission Policies via System Theories

In this section, the political system theories (Easton 1957; Lindblom and Woodhouse 1993) as shown in Fig. 3 are adopted for analyzing the admission policies of Hong Kong universities for Mainland students. The research questions such as what wider politics surround the policy issue, which institutions/actors are involved in the policy process and what the outcomes are answered. Specifically, the main sources of input of decision making are the demand and support under the current political environments. These two sources of input drive the production of the policy. After the decision making, the corresponding policies will be produced as the output. The policy will provide feedback to political environments. The feedback will bring possible changes in the political environments so that the new demands and supports will be produced in the next cycle. In the following, the admission policies will be examined based on the system theories.

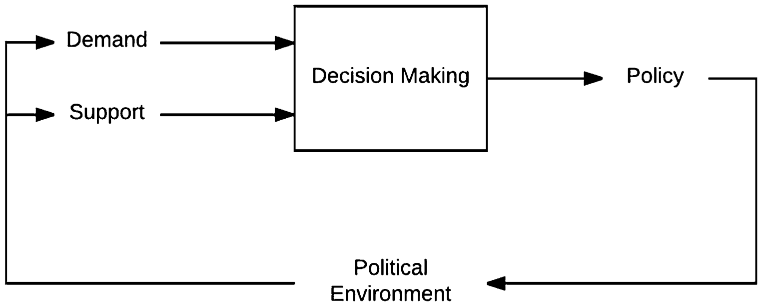

Fig. 3. The political system theories (Easton 1957; Lindblom and Woodhouse 1993)

- Initial Political Environment: After the Asia Financial Crisis (Chakrabarti and Roll 2002) and The Transfer of Sovereignty over Hong Kong in 1997, Hong Kong became more dependent on Mainland in terms of politics and economics. For example, Mainland has launched an "individual visiting scheme" for residents in PRC to promote the development of the tourism industry at Hong Kong ("Individual Visit Scheme" 2017). To stabilize Hong Kong in a certain period, the central government in PRC employed a policy called "one country, two systems" at Hong Kong ("Drafting and Promulgation of the Basic Law" 2017).
- Demand & Support: There have been various actors/institutions which support and/or demand increasing numbers of Mainland students in Hong Kong universities. The central government of PRC supports this because students can learn more advanced knowledge and skills from western countries, and also facilitate cultural

exchange and communication between Hong Kong and the Mainland. Hong Kong government, education bureau and UGC are also likely to benefit from this because they could get more support from the central government in PRC and attract more skilful talents to Hong Kong. For Hong Kong universities, they can recruit more students and incomes from the large Mainland market. For the other related parties such as the Hong Kong Professional Teaching Union, they are willing to see that more teacher posts will be available and teacher posts in universities become more stable. For other education-related companies such as publishers, they will have more opportunities and a larger market.

- Decision Making & Policy: The decision-making to produce more compatible admission policies of Hong Kong universities is in an incremental way. In 2004, the education bureau in Hong Kong and the Ministry of Education in PRC established "Memorandum of Understanding between the Mainland and Hong Kong on Mutual Recognition of Academic Degrees in Higher Education" ("Memorandum of Understanding" 2017). The academic degrees including bachelor, master and doctoral degrees in higher education are mutually recognized by Mainland and Hong Kong. In 2005, UGC withdrew the limitation of 20% non-local students for postgraduate programmes. In 2008, some Hong Kong universities such as The Chinese University of Hong Kong and City University of Hong Kong obtained the approvals from Ministry of Education of PRC to directly recruit Mainland students who have JEE results. From early 2010 till now, most Hong Kong universities accept JEE, CET, TEM as their admission requirements.
- Feedback to Political Environment: The rapid growth of Mainland students in Hong Kong universities receives resistance and opposite voices from localism organizations and institutions. For example, the NeoDemocrats (a party at Hong Kong) and the local society of Chinese University of Hong Kong made a claim that UGC and government should allocate more resources to local students ("NeoDemocrats Policies" 2017). With the localism movements such as "occupy central" (Lam 2015) and growth of localism organizations in recent years, the central government of PRC, the Hong Kong government, UGC, Education Bureau and Hong Kong universities become more deliberate to the topics and issues which are brought by admission policies.

4 Social Issues and Problems Caused by Admission Policies

The rapid increase of the number of Mainland students in Hong Kong universities has brought some social issues such as arguments about the medium of instructions and occupation of university resources, which will be discussed in the following subsections.

4.1 Arguments of the Medium of Instructions

Local Hong Kong students usually use Cantonese as their daily language, while non-local students from Mainland use Mandarin. In Oct 2013, there was a debate between Mainland and local students about the medium of instruction for a course in a master programme of Chinese at City University of Hong Kong as reported by Apple Daily ("Debate of medium of instructions" 2017). Specifically, non-local students argued that the course lecturer should use Mandarin to repeat the key contents in the course as 70% of the students of the class are from Mainland, while local students worried that the progress of the course will be slowed down if the lecturer repeated the contents. This event has further caused several arguments and even public debates in various social media platforms, forums and news media. Those who supported Mainland students argued that their requirements were reasonable. Firstly, most students in the class were from the Mainland. Secondly, they did not ask the lecturer to replace the Cantonese with Mandarin but only required a repetition of key contents. Thirdly, they were not fully adapted to the Hong Kong society as they had just been in Hong Kong for less than a month. However, the supporters of local students argued that the medium of instruction of the course was officially decided as Cantonese before the course selection period and Mainland students should adapt to local cultures. Some supporters of local students criticized that the admission policies of non-local students of Hong Kong universities were too market-driven so that too many Mainland students were enrolled. This case reflected that the linguistic gap (Maryns and Blommaert 2002) between Mainland and local students resulted in a confliction between two groups.

4.2 Occupation of University Resources

A common argument is that the Mainland students occupy many resources including student vacancies, residence quotas and scholarship quotas in Hong Kong universities ("NeoDemocrats Policies" 2017). Furthermore, there is no limit for non-local students in self-financed postgraduate programmes[2]. From the perspective of universities, they are willing to recruit more non-local students to increase their incomes, while the resources occupied by non-local students who need to pay the extra fee are quite limited. For example, City University of Hong Kong requires 120,000 HK dollars per annum for non-local students, while local students only need to pay 120,000 HK dollars per annum for the same undergraduate programmes. The resource allocation problem is inevitable during the process of internalization of a university (Bartell 2003).

5 Social Issues and Problems Caused by Admission Policies

There are several solutions to the above issues, two of which will be proposed in the following section, including some examples.

5.1 Provide Cantonese Training and Cultural Courses

Hong Kong universities do not normally provide pre-training courses for Mainland students. It is suggested that establishing Cantonese training courses or workshops for

[2] For undergraduate programmes, there is a limit of 20% for non-local students.

these students could better help them adapt to the local culture. The Chinese University of Hong Kong has set a serial of Cantonese courses to assist Mainland students to learn Cantonese within a few months ("Yale-China Chinese Language Centre" 2017). Unfortunately, many other universities do not provide such official training courses for these non-local students due to the expensive costs. To address this issue, the universities are advised to offer some open online courses and develop communities to better help non-local students learn Cantonese.

5.2 Provide Cantonese Training and Cultural Courses

To minimize the biased views of Hong Kong and Mainland students, Hong Kong universities are also suggested to have more exchange activities. A total of 3,849,100 Hong Kong residents had been to Mainland within a short period of time last year ("Characteristics of Hong Kong residents" 2017). However, only 0.1% was to exchange or study in Mainland. Furthermore, the exchange activities can establish better understanding and good impressions between Hong Kong and Mainland students. For example, four Hong Kong students who joined an exchange programme at Tsinghua University and Peking University had improved their impressions of Mainland and gained better national identities (Exchanging Hong Kong students 2017). The universities in Hong Kong are suggested to promote and launch more exchange programmes for local students to better understand the Mainland.

6 Summary and Future Work

In this study, the admission policies of Hong Kong universities for non-local students from the Mainland have been reviewed. The admission policies are analyzed within a three-dimensional framework including the institution categories, programme levels and place of origins. Furthermore, research questions such as what wider politics surround the policy issue, which institutions/actors are involved in the policy process and what the outcomes are answered by employing the political system theories. The related social issues and problems like arguments about the medium of instruction and occupation of university resources are also discussed. Furthermore, the possible solutions to these problems such as more exchanges between Hong Kong and Mainland students are proposed.

For future studies, one research direction is to investigate the working permit policies for non-local students in Hong Kong universities and identify the underlying relationships between the working permit policies and admission policies. Another interesting topic is to study policies related to tax and property for non-local students and graduates in Hong Kong.

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Gender Differences in Eye Movements During Online Reading

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Abstract. This paper provides evidence of individual difference on digital reading, by examining male/female and good/poor readers' eye tracking records (including pupil, blinks, fixations, saccades, and regressions). From 6,520 undergraduate students' university entrance exam scores and the follow-up reading assessments, we strategically selected 74 participants (half males and half females, top 3% good readers and bottom 3% poor readers) from different disciplines. Results indicated that the major differences between male and female readers were saccade duration, regression rate, and blink rate. Good and poor readers differ significantly in most of the eye tracking indicators, and the major effects of reading ability were more obvious than the gender effects. Among all the eight indicators examined in this study, blink and regression rates are most sensitive to gender attribute, while fixation rate and saccade amplitude presented least sensitiveness. These findings would be helpful for user modeling with eye-tracking data in intelligent tutoring systems.

Keywords: Gender difference · Reading ability · Eye movement · Individual difference · Eye tracking · Digital reading

1 Introduction

During the last several decades, some researchers tried to explore possible reasons for the gender differences in reading. One group of researchers explained the gender difference phenomenon from the perspective of reading strategies. Xu (2009) found significant differences in the selection and use of reading strategies between male and female middle school students, and that their reading strategies were strong predictors of learning performance.

On the one hand, more females than males like to use strategies during reading (Zhang et al. 2002). For example, Sheorey and Mokhtari (2001) found that females reported

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significantly higher frequency of overall strategy use, and they also used more supportive strategies than their male counterparts at the category level. Oxford and Nyikos (1989) came to a similar conclusion, stating that female students who have not been trained in using reading strategies still adopt strategies more often than male students.

On the other hand, as it is generally believed that females are good at memorizing and mimicking, and males are good at logic, synthesizing and analyzing, thus males and females can be expected to adopt different reading strategies. Wu et al. (1993) found that females' language learning strategies were more scientific, and their vocabulary memorization was stronger than that of males. Females tend to use compensation and affective strategies (Foong and Goh 1997), while males tend to use translation strategies (Bacon 1992). Lee (2012) found that male students reported greater strategy uses than their female counterparts in memory, cognitive, and compensation strategies, while fewer males than females used meta-cognitive and social-affective strategies while reading. In addition, males were more worried than females about unknown words during reading. Young and Oxford (1997) found that males reported using meta-cognitive (global) reading strategies, such as monitoring their reading pace and guessing, more often than females. Females, by contrast, tried to solve vocabulary problems and acknowledged their lack of background knowledge more often than males (Phakiti 2003).

Other researchers tried to determine the differences in the structures of different human brains, since the left and right brain are in charge of different aspects of language processing. The left brain is responsible for the explanation of the meaning of a word, while the right brain is responsible for interpreting its pronunciation. Also, left brain-dominated readers are more inclined to a field-independent cognitive style, and right brain-dominated readers are more oriented to be field-dependent. Oxford (1995) pointed out that males mainly use their left brain to participate in language activities and their right brain for spatial information processing, while females use both sides simultaneously for language and spatial activities. As a result, the division of left and right brains is not obvious, and has caused gender differences in reading abilities.

In recent years, a growing body of literature has sought a deeper understanding of gender differences in reading by examining eye-tracking data (Wang et al. 2010). Physiologically, our eyes are portals to our minds. For an ordinary human being, about 80 to 90% of information is obtained through the eyes (Wu and Shu 2001). While reading, readers' cognitive process also depends to a large extent on their visual system (Rayner et al. 2008). Compared to traditional survey studies on reading strategies that required readers to self-report their status, eye-tracking studies provide more reliable data that reflect readers' subconscious nature. In contrast to brain research, eye-tracking studies can record and analyze readers' behavior during their natural reading periods, rather than just recording their brain wave or ERP signals over a very short period. Thus the eye-tracking method seems highly suitable for studies on reading process.

It appears conceivable that eye movement patterns might be able to reveal gender differences in reading. Previous studies generally analyzed gender difference in reading test scores, reading strategies, or brain behaviors, with very limited consideration of students' eye movements. Even in some of the eye-tracking research, only one or two eye tracking indicators are analyzed, rather than taking the whole set into account. Thus, this study aims to provide empirical supports and gain more insight into the gender differences in reading. Specifically, we want to find out which eye-tracking indicator could best reflect individual difference (gender and reading ability), and explore whether there are different mechanism of eye movement indicators for good and poor readers.

2 Methods

2.1 Participants

The participants of this study were selected from 6,520 freshmen according to their Chinese test scores in the National College Entrance Exam. We invited the 150 students (top 3%) with the highest scores and the 150 students (bottom 3%) with the lowest ones to our lab to take a Chinese reading assessment and the Stanford-Binet IQ tests. Then we identified 74 of them (38 highest scored and 36 lowest scored) with equal number of male and females, as our eye-tracking experiment participants.

2.2 Measures for Selecting Eye-Tracking Experiment Participants

We generally used the Freshmen's Chinese Test Scores in the National College Entrance Exam, the Chinese Reading Assessment, Self-reported Survey, and IQ test to select eye-tracking experiment participants. The National College Entrance Exam is a national examination taken by all high school graduates before entering university. Since both the Chinese and English tests included assessments of reading abilities, we were mainly concerned with students' Chinese scores. However, when students had equal Chinese scores, we also took their English test scores into consideration. Based on 6,520 freshmen's test scores in the National College Entrance Exam, we targeted 300 participants for the next step: the Chinese reading assessment test.

A two-stage approach was used in the selection process. In the first stage, the 150 students (top 3%) with the highest scores and the 150 students (bottom 3%) with the lowest scores in the university entrance exam were selected as potential participants.

In the second stage, a Chinese reading assessment test was created based on previous reading assessment instruments (Ho et al. 2004; Hu 2012; Jiang 2007; Jin 2002; Leong et al. 2008; Yuan 2004; Yue 2009; Zou 2003). The assessment contained 58 test items (including 12 items of passage comprehension, 10 items of sentence comprehension, 10 cloze test items, 10 items of word comprehension, 8 items of orthographic test, and 8 items of phonological test). The internal consistency reliability for the test was determined to be 0.839. Students were required to finish all the test items within 100 min in our learning lab.

Participants' intelligence quotients were measured using the Stanford-Binet IQ test (Roid 2003), which is one of the most widely used IQ tests in the world and has been recognized as the most carefully developed and well respected instrument ever developed in the field of psychological assessment (Nelson and Dacey 1999; Silverman et al. 2010; Thorndike et al. 1986). It is suitable for ages ranging from 7 to 99 years old. There are 60 test items in total, all of which are in single-choice format. Participants were required to complete the test individually within 45 min.

A self-reported survey was created based on Chan et al. (2007) and Leong et al.'s (2008) research, as a way to judge students' reading abilities. The kappa coefficient was 0.71 ($p < 0.001$), indicating a moderately accurate prediction. Finally, 36 students with higher and 38 students with lower reading abilities were identified as target participants for this eye-tracking experiment.

2.3 Reading Materials in the Eye-Tracking Experiment

Reading materials consisted of 100 sentences for every eye-tracking experiment participant. Eighty of the sentences were accompanied by related questions for participants to answer. All the words were drawn from the Guang Ming Daily Corpus, and all the sentences were matched with identical sentence structure and balanced sentence length. In addition, we balanced the effect of word frequency in trials and made sure that half of the experimental trials contained high-frequency vocabularies and the other half low-frequency ones. All the reading materials were coded by E-prime 2.0 and presented to participants through a computer program in Song typeface, in a font size of 22. The accuracy of participants' answers was greater than 85%, indicating that participants were conducting the reading tasks seriously and carefully.

3 Results

The dependent variables in this study were five sets of readers' eye movement indicators: pupil, blink, fixation (fixation rate, fixation duration), saccade (saccade rate, saccade duration), and regression rate. All the data were exported from the eye-tracker, Eyelink II. The independent variables were students' gender (male vs. female) and reading ability (high vs. low). Table 1 presents the means and standard deviations of all the eye movement indicators.

3.1 Pupil

A MANOVA was conducted on participants' eye movement data, using reading ability and gender as the two fixed factors. Results revealed that gender and reading ability both have significant main and interaction effects on readers' pupil size. The findings indicated that male readers have significantly smaller pupil sizes than female readers: $F(1, 33102) = 180.169$, $p < .001$, $\eta^2 = .012$. Also, good readers have smaller pupil sizes than poor readers: $F(1, 33102) = 1235.447$, $p < .001$, $\eta^2 = .088$. For the interaction effect, $F(1, 33102) = 31.979$, $p < .001$, $\eta^2 = .003$, $R^2 = .098$.

3.2 Blink

The MANOVA result indicated that: (1) female readers blinked more than males: $F(1, 2940) = 61.531$, $p < .00$; (2) good readers blinked less than poor readers: $F(1, 2940) = 157.736$, $p < .001$; and (3) a significant interaction effect was found in gender*reading ability: $F(1, 2940) = 33.639$, $p < .001$, $\eta^2 = .011$, $R^2 = .073$.

Table 1. Means and standard deviation of readers' eye movements

Eye movement indicators			Readers with good ability (n = 38)			Readers with poor ability (n = 36)		
			Male	Female	Total	Male	Female	Total
			N' = 9041	N' = 7658	N' = 16699	N' = 8794	N' = 7610	N' = 16404
Pupil	Pupil size	Mean	1594.24	1789.12	1728.82	2138.54	2182.54	2159.14
		St. Dev.	617.683	597.015	636.466	915.186	581.219	760.841
Blink	Blink rate	Mean	0.16	0.22	0.19	0.36	0.75	0.54
		St. Dev.	0.579	0.527	0.552	0.704	1.204	0.994
Fixation	Fixation rate	Mean	11.7	10.45	11.01	11.83	12.66	12.22
		St. Dev.	5.732	4.349	5.049	5.133	5.898	5.525
	Fixation duration	Mean	226.82	228.65	227.84	234.3	226.26	230.4642
		St. Dev.	41.42	38.6	39.877	42.68	36.93	40.22944
Saccade	Saccade rate	Mean	10.81	9.57	10.12	10.95	11.79	11.35
		St. Dev.	5.727	4.328	5.035	5.12	5.877	5.508
	Saccade duration	Mean	32.38	37.07	31.03	36.62	40.46	34.93
		St. Dev.	24.934	28.733	23.592	30.806	39.434	34.263
	Saccade amplitude	Mean	3.05	3.24	3.15	3.07	2.98	3.03
		St. Dev.	1.041	0.998	1.021	1.158	0.993	1.083
Regression	Regression rate	Mean	8.33	6.66	7.41	11.83	12.66	12.23
		St. Dev.	5.392	4.478	4.973	5.133	5.897	5.524

3.3 Fixation

3.3.1 Fixation Rate

With regard to fixation rate, the main effect of gender was not significant: $F(1, 2940) = 1.183$, $p = .277$, $\eta^2 = .012$. However, the main effect of reading ability was significant, with good readers having fewer fixations per trial than poor readers: $F(1, 2940) = 37.471$, and $p < .001$. The interaction effect is also significant: $F(1, 2940) = 29.612$, $p < .001$. $\eta^2 = .010$, and $R^2 = .022$.

3.3.2 Fixation Duration

With regard to fixation duration, although the main effect of reading ability was significant, poor readers had significantly longer fixation than good ones: $F(1, 33102) = 18.562$, $p < .001$, $\eta^2 = .001$, $R^2 = .022$. The main effect of gender was also significant: males made longer fixations than females, with $F(1, 33102) = 9.664$, $p = .002$, and $\eta^2 < .001$. The interaction effect was also significant, though not very obvious: $F(1, 33102) = 6.432$, $p = .011$, $\eta^2 < .001$, and $R^2 = .001$.

3.4 Saccade

3.4.1 Saccade Rate

With regard to saccade rate, the main effect of reading ability was significant: good readers made significantly fewer saccades than poor readers: $F(1, 2940) = 38.539$, $p < .001$, and $\eta^2 = .012$. No significant difference was found on the main effects of gender: $F(1, 2940) = 1.099$, and $p = .295$. The interaction effect was significant: $F(1, 2940) = 29.846$, $p < .001$, $\eta^2 = .010$, $R^2 = .022$.

3.4.2 Saccade Duration

With regard to saccade duration, good readers had significantly shorter saccade duration than poor readers: $F(1, 33102) = 145.031$, $p < .001$, and $\eta^2 = .004$, and females had significantly longer saccades than males: $F(1, 33102) = 4.227$, $p = .027$, and $\eta^2 = .004$. The effect size (based on Cohen's d) was 0.29 (Cohen's $d = 0.56$). No interaction effect was found between reading ability*gender: $F(1, 33102) = 0.552$, and $p = .485$.

3.4.3 Saccade Amplitude

With regard to saccade amplitude, the main effect of reading ability was significant: good readers had significantly larger saccade amplitudes than poor readers: $F(1, 33102) = 26.545$, $p = .001$, and $\eta^2 = .003$. No significant difference was found in the main effect of gender: $F(1, 33102) < .001$, and $p = .995$. However, the interaction effect was significant: $F(1, 33102) = 37.305$, $p < .001$, $\eta^2 = .001$, and $R^2 = .002$.

3.5 Regression

With respect to regression rate, good readers made significantly fewer regressions than poor readers: $F(1, 2940) = 633.193$, $p < .001$, and $\eta^2 = .170$. Females made more regressions than males: $F(1, 2940) = 4.927$, $p = .027$, and $\eta^2 = .002$. The interaction effect was significant: $F(1,2940) = 43.857$, $p < .001$, $\eta^2 = .014$, and $R^2 = .185$.

4 Discussion

4.1 Gender Difference on Eye Movements

Among all eight indicators, blink rate, regression rate, and saccade duration have the strongest main effects of gender difference, which indicates the best discrimination of gender. Fixation duration, pupil size, and regression rate are the second choices for gender-related eye-tracking indicators, with significant difference, but not consistently in good and poor reader samples. Besides, fixation rate, saccade rate, and saccade amplitude are indicated to be non-gender-related, which have no significant difference between male and female readers.

Specifically, previous studies associated blink rate with mental workload (Wolkoff et al. 2005; Tsai et al. 2007), and females are usually more prudent and have a higher cognitive load. In a relaxed state, the average person's blink rate is much higher than that in readers who need to be highly focusd (Tecce 1992). Female readers might be more engaging on reading than males. Also, females might do better in the lexical activation and sentence integration processes (Chapman and Underwood 1998), resulting in lower regression rates. Our study could be an evidence supports future studies using blink rate, saccade duration, and regression rate as major indicators of gender-related eye-tracking research.

4.2 Individual Difference on Eye Movements Between Good and Poor Readers

All the eight eye-tracking indicators in consideration are sensitive for reading abilities. Specifically, the fixation rate, saccade rate, and regression rate are the most sensitive ones with biggest effect size. This is consistent with the previous research (Zhan et al. 2016). Fixation rate is related to participants' cognitive load and experience (Clifton et al. 2007). Experts usually have fewer fixations than novice. A high number of fixations indicated the interpreting difficulties on the fixated information (Ehmke and Wilson 2007). Thus fixation rate should be able to distinguish poor readers from proficient ones. Likewise, saccade rate can indicate task difficulty, mental workload (Nakayama et al. 2002), and readers' fatigue levels. Also, readers with dyslexia would have more regressions than normal readers (Kuperman and Van 2011; Rayner et al. 2013).

4.3 Implication for User Modeling in Intelligent Tutoring System

Previous study had suggested eye-tracking technique embedded in the Intelligent Tutoring System (ITS) to evaluate learners' reading abilities (Zhan et al. 2016). The findings of this study provide implications for user modeling by choosing suitable eye-tracking indicators. Since male and female differed significantly on saccade duration, regression rate, and blink rate, these indicators should be used carefully when building up the user model. We could either avoid using them, or use them by controlling the gender effects cautiously. On the other hand, fixation rate and saccade rate are sensitive for reading abilities with little gender difference, thus might be considered as better indicators in the evaluation model.

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The Relationship Between Online Learning Behavior and Metacognition Based on Structural Equation Model

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Abstract. With the rapid development of online learning, people are paying more and more attention to various factors that influence learners' online learning behavior, especially the psychological factors related to learning. Based on the existing research results, this study focuses on the relationship between metacognition and online learning behavior, and constructs a structural relationship model. Through the analysis of 440 questionnaires, this study uses structural equation modeling to explore the relationship between them. The results show that metacognitive monitoring has a significant and positive direct impact on the three levels of online learning behavior, while metacognitive knowledge and metacognitive experience has an indirect impact on online learning behavior which take metacognitive monitoring as a mediator variable. At the same time, metacognitive monitoring and informational interactive behavior are important factors affecting conceptual interactive behavior, and metacognitive monitoring can also influence the conceptual interactive behavior through direct or indirect methods.

Keywords: Metacognition · Online learning behavior · Structural equation model

1 Introduction

At the beginning of the 21st century, the OER movement has become the starting point for the global online education. The Massive Open Online Course that emerged around 2012 has pushed OER to a climax. Online learning has also become one of the best ways to learn. Among them, online learning behavior is one of the performances of learners in the online learning process of learners, and it is one of the important indicators to evaluate learners' online learning and teachers' online teaching effects (Zhu 2015, p. 114). The analysis and evaluation of the learner's online learning behavior is conducive to a deep understanding of the learner's learning situation and activity mechanism, which is an important basis for the design of online courses (Wei 2012).

However, in recent years, many studies have found that learners generally have the following types of problems in the process of online learning (Wang 2009). Internet time is long, but less time spent meaningful learning. Online learning is not very active.

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Self-learning ability is not strong. Lack of awareness of the use of network technology for knowledge sharing and so on (Kong 2017). At the same time, in the process of online learning, learners' self-reflection, metacognition and other cognitive activities have relatively little research on the relationship between learning behaviors (Wei 2012).

In response to this problem, this study focuses on the relationship between online learning behavior and metacognitive, and uses structural equation modeling to verify and analyze their relationship model, in order to explore effective strategies to improve learners' online learning performance.

2 Construction of the Relational Model

Based on the research on online learning behavior and metacognition, this study constructed a structural model of online learning behavior and metacognition, as shown in Fig. 1.

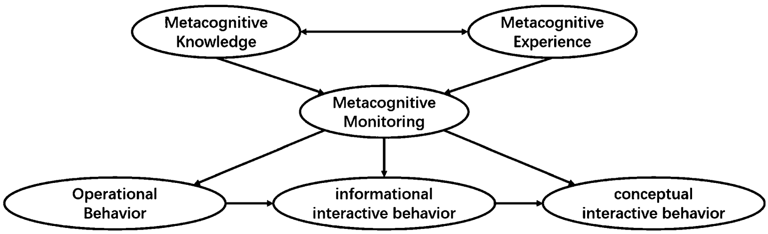

Fig. 1. Relational model of online learning behavior and metacognition

2.1 The Categories of Online Learning Behavior and Their Relationships

From the analysis of existing research, one classification method of online learning behavior is to divide the behavior according to abstraction or complexity. For example, Chen et al. (2004) divides the learning interaction behavior in distance education according to the degree of abstraction, forming a teaching interaction hierarchy composed of operational behavior, informational interactive behavior and conceptual interactive behavior. Peng et al. (2013) divides online learning behavior into operational behavior, cognitive behavior, collaborative behavior and problem-solving behavior from the perspective of complex behavior.

Based on the existing research, this study analyzes the online learning behavior from the abstraction level and divided into three levels: *operational behavior, informational interactive behavior and conceptual interactive behavior*. Based on this, the following hypotheses can be made.

H1 operational behavior has a significant and positive impact on informational interactive behavior

H2 informational interactive behavior has a significant and positive impact on conceptual interaction behavior

2.2 The Components of Metacognition and Their Relationships

The concept of metacognition originated from the study of "memory of memory" and was first proposed by Flavell (1976). Flavell (1979) generalizes metacognition as "the individual's awareness and regulation of his/her own cognitive state and process", and divides metacognition into two main components: metacognitive knowledge and metacognitive experience, while domestic scholars tend to think that metacognition consists of three components: metacognitive knowledge, metacognitive experience and metacognitive monitoring (Chen 1996; Dong 1989).

Based on Flavell's research in 1985, there is a two-way relationship between metacognitive knowledge and metacognitive experience. The metacognitive experience can activate the related metacognitive knowledge in long-term memory and return it to working memory. Serving the current metacognitive activities; metacognitive knowledge helps individuals understand the meaning of the metacognitive experience, and runs the corresponding knowledge in the activity to better understand the situation and produce relevant experience. At the same time, metacognitive knowledge and metacognitive experience provide information and knowledge for the process of metacognitive monitoring.

In this study, we measure and analyze metacognition in cross section. Therefore, the metacognitive relationship model established in this study does not consider the role of metacognitive monitoring in the next round of metacognitive activities. Finally, the structural relationship model between the three elements of metacognition in this study is constructed, as shown in Fig. 2.

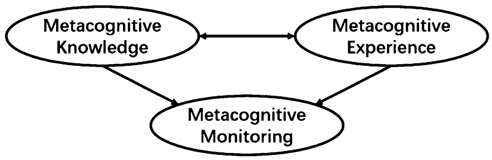

Fig. 2. The structural relationship of the three elements of metacognition

Based on the above conclusions, the following hypotheses can be made:

H3 There is a positive correlation between metacognitive knowledge and metacognitive experience, that is, interaction between the two
H4 metacognitive knowledge has a significant and positive impact on metacognitive monitoring
H5 metacognitive experience has a significant and positive impact on metacognitive monitoring

2.3 The Relationship Between Metacognition and Online Learning Behavior

Metacognitive monitoring refers to the process in which the subject actively and consciously monitors, controls, and regulates the cognitive activities that are being carried out by the subject in the process of performing cognitive activities (Dong 1989). In recent years, some scholars have carried out experimental research on metacognition from the perspectives of cognitive and brain science. For example, Shea and Boldt (2014) constructed a "dual system" of metacognition based on the research of brain science, and emphasized that metacognitive monitoring is based on information such as cognition and decision-making, and has a direct impact on the cognitive behavior itself. Kralik and Lee (2019) also pointed out that metacognitive monitoring will adjust and control the effect system based on the signals of other decision processes, that is, adjust and control the cognitive response and behavioral activities. Thus, in this study, it can be concluded that metacognitive monitoring has a direct impact on the online learning behavior of this effect system. Based on this, the following hypotheses can be made:

H6 metacognitive monitoring has a significant and positive impact on operational behavior

H7 metacognitive monitoring has a significant and positive impact on informational interactive behavior

H8 metacognitive monitoring has a significant and positive impact on conceptual interaction behavior

Kralik and Lee (2019) also pointed out that the various signals affecting metacognitive monitoring come from the knowledge and experience generated when receiving environmental stimuli, and input this information into the decision system in the process of such perception, that is, input to metacognitive monitoring. Metacognitive knowledge is the declarative, procedural and conditional knowledge stored in the individual's long-term memory. According to the relevant theory of memory, the attempt to remember the knowledge does not directly affect the individual's current cognitive and behavioral activities. Only activated into working memory can it be used by individuals to provide guidance for conditioning and surveillance activities. Similarly, the primary role of the metacognitive experience is to provide the necessary information for regulation and monitoring activities (Zhang 2012). Therefore, in the structural model shown in Fig. 1, neither metacognitive knowledge nor metacognitive experience has a direct impact on online learning behavior, but it has an indirect influence through metacognitive monitoring. Based on this, the study proposes two hypotheses about mediating effects as follows:

H9 metacognitive knowledge plays a positive role in the process of metacognitive monitoring on behavior.

H10 metacognitive experience plays a positive role in the process of metacognitive monitoring on behavior.

3 The Design of the Research

3.1 Research Content

This study aims to analyze the current college students' metacognitive level and online learning status by measuring the scale of Guangzhou University students who have participated in online learning. Based on this, the theoretical relationship model proposed above can be verified in order to explore the structure and quantity relationship between metacognition and online learning behaviors.

3.2 Research Object

In this study, a stratified sampling method was used for questionnaire survey. The research subjects are from 6 universities in Guangdong Province. In the end, 582 questionnaires were collected and 440 valid questionnaires, with an effective rate of 75.6%. The professional distribution is: social science for 43.64%, science and engineering accounted for 52.92%, and others accounted for 3.44%. Data analysis and processing mainly use SPSS23 and Mplus7.4.

3.3 Research Tool Design

This study compiled a questionnaire about metacognitive measurement and online learning behavior analysis, and based on the relationship structure model between metacognition and online learning behavior, compiled a questionnaire on online learning behavior and metacognition of college students, which included online learning behavior measurement scale and metacognitive measurement scale. The final measurement scale and the survey of basic information have a total of 23 items. The design and reference sources of the questionnaire are shown in Table 1.

Table 1. Questionnaire item design and reference source

Questionnaire dimension		Numbers	The source of problem
Learner's basic information		4	Self-edited
Metacognition	Metacognitive knowledge	3	Zhang (2012); Self-edited
	Metacognitive experience	3	
	Metacognitive monitoring	4	
Online learning behavior	Operational behavior	3	Li (2013); Self-edited
	Informational interactive behavior	3	
	Conceptual interactive behavior	3	

4 Analytics

4.1 The Test of the Relational Model

4.1.1 Measurement Model

The test of the measurement model includes three parts: reliability, convergence validity, and differential validity. Table 2 shows the reliability and convergence validity of the measurement model. The reliability test includes the topic reliability and composition reliability. In the table, MK represents metacognitive knowledge, ME represents metacognitive experience and MM represents metacognition monitoring respectively. OB represents operational behavior, IIB represents informational interactive behavior and CIB represents conceptual interaction behavior.

Table 2. Reliability and convergence validity

Dim.	Item	Significant test				Item reliability	Composite reliability	Convergence validity
		Estimate	S.E.	Est./S.E.	P-value	R-square	CR	AVE
MK	MK1_1	0.811	0.022	36.126	***	0.658	0.868	0.688
	MK1_2	0.911	0.019	47.603	***	0.830		
	MK1_3	0.760	0.025	30.616	***	0.578		
ME	ME2_1	0.701	0.034	20.603	***	0.491	0.785	0.549
	ME2_2	0.783	0.032	24.110	***	0.613		
	ME2_3	0.737	0.033	22.174	***	0.543		
MM	MM3_1	0.780	0.023	34.359	***	0.608	0.885	0.659
	MM3_2	0.838	0.019	44.194	***	0.702		
	MM3_3	0.844	0.019	45.229	***	0.712		
	MM3_4	0.783	0.023	34.748	***	0.613		
OB	OB1_1	0.731	0.033	21.959	***	0.534	0.799	0.577
	OB1_2	0.909	0.032	28.465	***	0.826		
	OB1_3	0.608	0.036	16.667	***	0.370		
IIB	IIB2_1	0.768	0.032	24.311	***	0.590	0.794	0.563
	IIB2_2	0.701	0.033	21.148	***	0.491		
	IIB2_3	0.780	0.031	24.896	***	0.608		
CIB	CIB3_1	0.855	0.022	39.068	***	0.731	0.857	0.667
	CIB3_2	0.796	0.024	33.096	***	0.634		
	CIB3_3	0.798	0.024	33.319	***	0.637		

***$p < .001$

As can be seen from Table 2, the factor loading of each dimension is greater than 0.6. At the same time, all P-values are less than 0.001, which is significant. Among them, the item reliability indicates the degree of interpretation of the topic by the dimension, and the larger the value, the more the dimension can explain the change of the items. In general, a item reliability value greater than 0.36 is acceptable, and a value greater than 0.67 indicates good topic reliability (Urbach and Ahlemann 2010). It can be seen from the values of the table that the value of the item reliability is basically between 0.5 and 0.8, which indicates that the reliability of the topic is good. The composite reliability CR is the degree of internal consistency of the dimension, when CR greater than 0.7 indicates better composition reliability (Fornell and Larcker 1981). It can be seen from the table values that the composite reliability of the measurement model is higher than 0.78. The last column of the table shows the convergence validity AVE, which indicates the average explanatory power of the dimension to the topic. AVE is greater than 0.36 is acceptable, and greater than 0.5 indicates that the topic has good convergence validity. It can be seen from the table values that the measurement model has good convergence validity. Table 3 shows the comparison between the differential validity and the convergence validity of the measurement model.

Table 3. Comparison of differential validity and convergence validity

Dim.	Convergence validity	Difference validity					
	AVE	MC1	MC2	MC3	OB1	OB2	OB3
MK	0.688	**0.829**					
ME	0.549	0.866	**0.741**				
MM	0.659	0.653	0.825	**0.812**			
OB	0.577	0.340	0.345	0.537	**0.760**		
IIB	0.563	0.503	0.573	0.662	0.814	**0.750**	
CIB	0.667	0.548	0.614	0.749	0.588	0.881	**0.817**

It can be seen from Table 3 that the diagonal line of "differential validity" shows the square root value of the convergence validity of each dimension, and the lower triangle is the Pearson correlation coefficient between the dimensions. The test of the differential validity needs to compare the values of the diagonal and the lower. By comparison, it is found that the square root of AVE on the diagonal is substantially higher than the corresponding Pearson correlation coefficient, and some of the non-conformities are also within the acceptable range. It can be seen that the measurement model has certain differential validity.

4.1.2 Structural Model

After the confirmatory factor analysis is completed, the fitness test of the structural equation model can be performed. The modification indexes are shown in Table 4.

Table 4. Modification indexes

Modification index	Chi value	df	X^2/df	RMSEA	CFI	TLI	SRMR
Suggested value	–	–	<3.0	<0.08	>0.9	>0.9	<0.08
Model indicator	245.246	144	1.703	0.040	0.965	0.959	0.044

When examining the degree of fitness of a structural model, it is often necessary to combine multiple indicators. Among them, the numerical requirement of X2/df is less than 3.0, the RMSEA and SRMR are both required to be less than 0.08, and the CFI and TLI requirements are greater than 0.9 (Iacobucci 2010). It can be obtained that the model meets the above five indicators, so the model can be considered to have a high degree of fitness, that is, the constructed theoretical model can explain the actual data.

4.2 The Test of the Research Hypothesis

Based on the hypotheses made during model construction, based on the output of Mplus, the hypotheses test table shown below can be constructed.

In addition, H3 refers to the correlation between metacognitive knowledge and metacognitive experience. According to the analysis result, the correlation coefficient value of the two is 0.863, and the P-value is less than 0.001.

4.2.1 Structural Relationship Between Different Online Learning Behavior

Based on the results of Table 5, the operational behavior has a significant positive impact on the information interaction behavior (factor loading = 0.590, $p < 0.001$), that is, hypothesis H1 is valid, indicating that the learner's highly skilled operational behavior is conducive to the occurrence of informational interactive behavior, which can help learners make better use of various tools to acquire, process and share information. At the same time, the informational interactive behavior also has a significant positive impact on the conceptual interactive behavior (factor loading = 0.626, $p < 0.001$), that is, hypothesis H2 is valid, indicating that the learner's positive informational interactive behavior can promote its learning activities such as construction and criticism promote the effective occurrence of conceptual interactions and achieve true deep learning.

Table 5. Research hypotheses test

Hypothesis	Indep. var.	Dep. var.	Estimate	Std. E	Z-value	P-value
H1	OB	IIB	0.590	0.052	11.320	***
H2	IIB	CIB	0.626	0.070	8.966	***
H4	MK	MM	−0.207	0.155	−1.334	0.182
H5	ME	MM	1.004	0.160	6.295	***
H6	MM	OB	0.517	0.051	10.036	***
H7	MM	IIB	0.358	0.059	6.111	***
H8	MM	CIB	0.336	0.069	4.853	***

***$p < .001$

4.2.2 Structural Relationship Within Metacognition

According to the output of Mplus, there is a positive and significant correlation between metacognitive knowledge and metacognitive experience (correlation coefficient = 0.863, $p < 0.001$), that is, hypothesis H3 is valid. However, as can be seen from Table 5, metacognitive knowledge has no significant effect on metacognitive monitoring (factor loading = −0.207, $p = 0.182 > 0.1$), while metacognitive experience has significant positive impact (factor loading = 1.004, $p < 0.001$) for metacognitive monitoring. Based on the above analysis, this study attempts to analyze whether metacognitive knowledge has an indirect impact on metacognitive monitoring, that is, metacognitive knowledge uses metacognitive experience as a mediator variable, which in turn affects metacognitive monitoring. Based on this speculation, this study reconstructs the structural relationship diagram of the internal elements of metacognition as shown in Fig. 3. The analysis results show that the estimate value of "metacognitive knowledge → metacognitive experience → metacognitive monitoring" is 0.853, $p < 0.001$, and the 95% confidence interval output by Bootstrap is [0.572, 1.330]. The effect is established and significant (Hays 2009), and combined with the conclusion that the direct effect is not valid, it can be proved that the relationship between metacognitive knowledge and metacognitive monitoring is a complete mediation effect. It is thus proved that metacognitive knowledge does not directly affect metacognitive monitoring, but plays a role of complete mediation through metacognitive experience.

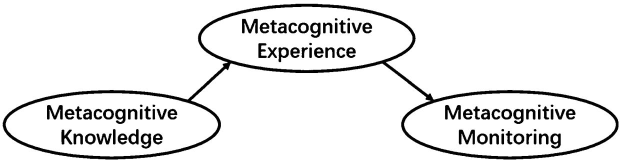

Fig. 3. Structural relationship of internal elements of metacognition

According to Zhang's research, metacognitive knowledge belongs to the knowledge in long-term memory, so it cannot directly affect behavior. Only when metacognitive knowledge is called to working memory can it play a certain role in regulating behavior (Zhang 2012). Based on the above research and the situation of this study, the following conclusions can be drawn: the metacognitive experience analyzes and perceives the activity scenarios, and based on this, activates the metacognitive knowledge in long-term memory to enter the working memory. Based on the perceived situation of metacognitive experience, a certain metacognitive monitoring strategy is used to regulate behavior.

4.2.3 Relationship Between Metacognition and Online Learning Behavior

According to Table 5, metacognitive monitoring has a significant positive impact on operational behavior (factor loading = 0.571, $p < 0.001$), informational interactive behavior (factor loading = 0.358, $p < 0.001$) and conceptual interactive behavior (factor loading = 0.336, $p < 0.001$), that is, H6 ~ H8 are valid. It can be seen that an important way to improve the performance of learners' online learning behavior is to enhance learners' ability and awareness of using metacognitive monitoring to plan and adjust their learning behaviors.

However, the path values of the above three assumptions, that is, the factor loading is not very high. Therefore, this study tries to analyze the possible indirect effects between the elements of metacognition and online learning behavior, and analyze the indirect effects more deeply, that is, analyze the hypothesis H9 and H10. At the same time, through the above model analysis, we adjust the original structural model and output a new structural model, as shown in Fig. 4.

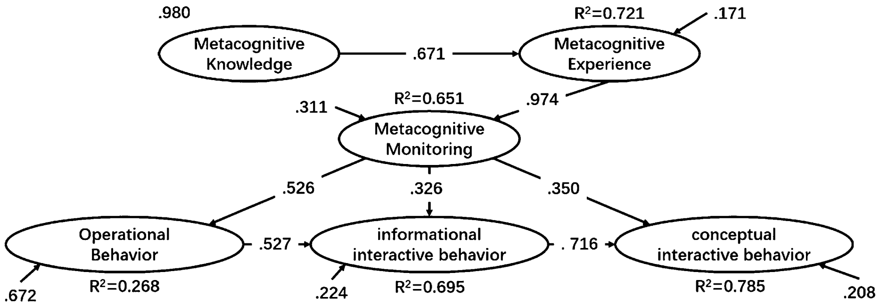

Fig. 4. Revised structural model of metacognition and online learning behavior

4.3 The Analysis of Mediation Effect

4.3.1 Total Mediation Effect

The output of the modified structural model indicates that there is a significant structural relationship between the variables, and the total indirect effects between them are shown in Table 6.

Table 6. Total mediation effect

Dep. var.	Indep. var.	Point estimate	Product of coefficients			BOOTSTRAP 3000 TIMES 95%CI			
						Bias corrected		Percentile	
			S.E.	Z-value	P-value	Lower	Upper	Lower	Upper
OB	MK	0.344	0.052	6.615	***	0.254	0.463	0.250	0.456
OB	ME	0.512	0.084	6.131	***	0.375	0.702	0.370	0.692
IIB	MK	0.394	0.059	6.673	***	0.291	0.525	0.245	0.516
IIB	ME	0.587	0.094	6.251	***	0.421	0.796	0.419	0.791
IIB	MM	0.277	0.056	4.963	***	0.181	0.402	0.176	0.394
CIB	MK	0.511	0.067	7.608	***	0.391	0.662	0.387	0.656
CIB	ME	0.761	0.116	6.545	***	0.498	1.001	0.559	1.009
CIB	MM	0.431	0.073	5.871	***	0.304	0.598	0.299	0.589

***p < .001

It can be concluded from the above table that 95% of the confidence intervals of each path do not contain 0, which proves that the indirect effect exists. At the same time, the P-value of the point estimate is less than 0.001, that is, the indirect effect is significant. It can also prove that metacognitive knowledge and metacognitive experience are indirectly affecting online learning behavior through metacognitive monitoring (Hayes 2009).

It can be proved that both H9 and H10 are assumed to be true.

4.3.2 Analysis Different Impacts of on Conceptual Interactive Behavior

In the online learning behavior, the conceptual interactive behavior has the highest degree of abstraction, and it can best indicate the learner's deep learning situation. Therefore, in this section we will focus on the various impacts on conceptual interactive behavior.

First, metacognitive monitoring and informational interaction behaviors both have direct impact on conceptual interactive behavior. According to Table 5, the direct effect of metacognitive monitoring on conceptual interactive behavior is 0.336 ($p < 0.001$), while the direct effect estimation of information interaction behavior on conceptual interaction behavior is 0.626 ($p < 0.001$). At the same time, the R2 of the conceptual interaction behavior reached 0.784, that is, the degree of interpretation is good. This shows that the most important factors affecting the conceptual interactive behavior include metacognitive monitoring and information interactive behavior.

Then, by analyzing the indirect effects of metacognitive monitoring on conceptual interactive behavior, the estimate is 0.431 ($p < 0.001$), and the confidence interval of Bootstrap sampling estimation does not contain 0, which indicates that metacognitive monitoring interacts with conceptual interactive behavior has a positive and significant indirect effect. At the same time, the estimated value of indirect effect is greater than the direct effect's estimate which is 0.336 ($p < 0.001$). Then, by comparing the indirect effects of metacognitive knowledge and metacognitive experience on conceptual interaction behavior, the numerical values are lower than the influence of metacognitive monitoring, that is, metacognitive monitoring is the key factor that influents conceptual interactive behavior.

5 Conclusion

5.1 Relationship Between Metacognition and Online Learning Behavior

Metacognition, as a high-level ability of learners to perceive, plan, and regulate their own cognitive and behavioral activities, has an important impact on learners' online learning behavior. This study explores and derives the relationship between metacognition and online learning behavior through structural equation modeling. Metacognition monitoring has a positive direct positive effect on online learning behavior, while metacognition knowledge and metacognition experience play an indirect role through metacognition monitoring.

Through the comparative analysis of the direct and indirect effects of the structural model, this study finds that metacognition monitoring and informational interactive behavior are important to the conceptual interactive behavior. Metacognition monitoring not only directly affects the conceptual interactive behavior, but also has a significant and positive indirect impact on the conceptual interactive behavior through operational behavior or informational interactive behavior. Therefore, in the actual online learning process, it is necessary to promote the active informational and personal interaction. In addition to the interaction between the learner and the learning resources, it is necessary to pay special attention to the interpersonal interaction of the learners with other learners and teachers, which can gain more knowledge and information that will help deep learning. At the same time, in the process of interaction, attention should be paid to the use of metacognition strategies.

5.2 Learning Intervention Strategy Based on the Model

The structural relationship model finally derived from this study has very important theoretical guiding for the design and implementation of learning intervention strategies for online learning behavior. In recent years, some studies have begun to focus on the design of online learning systems based on metacognition (Zheng and Yu 2008), and the corresponding methods of training metacognition strategies (Zhao and Cai 2007). Combining the conclusions of this study with other related research, we believes that the learner's metacognition ability can be cultivated from five aspects: learning goal planning, learning process monitoring, learning situation reflection, learning problem diagnosis and learning behavior regulation. Based on this, learn learners' online learning behavior can be improved from the learners' learning psychological aspect.

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Pedagogical, Psychological and Cultural Issues

An Exploratory Study on the Part-Time Teaching Staff Engagement on Canvas for Teaching and Learning in Higher Education

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Abstract. The use of Virtual Learning Environments (VLEs) is an essential component of the teaching and learning strategy in higher education. This research paper aims to fill a gap in the literature by exploring the levels of utilisation of the Canvas VLE by part-time teaching staff at a higher education institution in Hong Kong with a view to understanding the factors influencing the level of use by teaching staff and pointing to how its use could further be enhanced for an improved teaching and learning experience. A survey of current academic research literature on VLE engagement by teachers was carried out in conjunction with structured questionnaires and interviews with teaching staff of the Hong Kong Higher Education (HE) institution. Issues in the research literature were corroborated by survey and interview findings and included lack of preparation time, lack of familiarisation with VLE features and technical issues. To address these issues, strengthening of preparation by teaching staff through practical familiarisation with the use of the VLE coupled with the dissemination of adequate instructional resources for both teaching staff and students supported by robust training sessions in the use of interactive communication features of the VLE were recommended.

Keywords: Virtual learning environment · VLE · eLearning · Canvas · Hybrid learning · Teaching and learning · Tertiary education

1 Introduction

The use of Virtual Learning Environment (VLE) to support student learning at tertiary education institutions have become a more essential component of the eLearning support provided to students. This is of particular importance when hybrid learning approaches are used where the student is able to utilise online resources to supplement their learning. This study will look at how much academics utilise the VLE in their teaching to enhance student's learning during face-to-face teaching. This study will investigate the current literature for coverage of specific VLE engagement patterns by academics and identify gaps in the knowledge, in particular, if other studies have covered the Instructure Canvas VLE engagement by academics in Hong Kong tertiary

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institutions specifically. The researchers aim to find out what factors affect academic engagement. Findings from questionnaires will be compared with a one-to-one telephone interview to validate the findings. It is hoped then that the findings will assist in providing useful guidelines for the academic teaching staff in Hong Kong who use the Canvas VLE to improve academic VLE engagement.

2 Literature Review

The use of Virtual Learning Environment (VLE) as part of the teaching and learning pedagogy at higher education institutions is widespread, and these systems are upgraded regularly to incorporate improvements. We will look at what the literature says about Virtual Learning Environment in general, the different modes of eLearning in HE institutions and the engagement of academic staff in the use of VLE.

2.1 Virtual Learning Environment

Cassidy (2016) defines a VLE as an online-based system of software applications that facilitates the following: online communication and cooperative learning, uploading of instructional content by teaching staff, online student assessment and feedback provision, online course administration. Other authors refer to a Learning Management System (LMS), which meanwhile is defined as a web-based application designed to manage online learning, helps educators and students to share and distribute materials and interact with each other online (Raga and Rodavia (2018); Ohliati and Abbas (2019)). Content Management Systems (CMS) is another term used to refer to tools such as WordPress which manage the creation and amendment of digital content such as documents, audio, video or photos, in a collaborative environment. For the purposes of this study however, and following Tayşi and Başaran (2018), VLE will be used interchangeably with LMS, and which could either be one of three types: proprietary, Software as a Service (SaaS)/Cloud or open source.

VLEs/LMSs are widely used by many types of organisations to deliver training and education courses. eLearning industry lists the top 20 open sources Learning Management Systems for 2019 in Table 1.

According to edutechnica's 6th Annual LMS Data Update (2018) on LMS usage in the higher education industry in the USA, the top 4 according to percentage of institutional usage are Blackboard Learn (31%), Instructure Canvas (30%), Moodle (18%) and D2L Brightspace (12%).

Instructure's cloud-based Canvas LMS was developed by a U.S. company in 2011 and is now being used by more than 3,000 universities, school districts and higher education was introduced to the U.K. in 2014. It has now been adopted for use at various HE institutions such as the University of Birmingham, Imperial College London in the UK and Hong Kong by the City University of Hong Kong and the Hong Kong University of Science and Technology. Canvas comes with a suite of features including a common space for sharing, assessment marking and annotation, analytics reporting, media recording, notifications, ease of use, availability through mobile devices among other features. This study will focus primarily on the use of the Instructure Canvas VLE as applicable to tertiary education programmes in Hong Kong.

Table 1. List of the top 20 open source learning management systems for 2019

	Name of LMS	Developed by	Year introduce to the market
1	Moodle	Moodle HQ	2002
2	Chamilo	Chamilo Association	2010
3	Open edX	Harvard and MIT	2012
4	Totara Learn	Totara	2013
5	Canvas	Instructure	2011
6	Forma	Forma	2013
7	Effectus	Effectus	2017
8	ILIAS	ILIAS	1998
9	OpenOLAT	frentix GmbH	2011
10	Opigno	Opigno	2012
11	.LRN	MIT	2002
12	ATutor	OCAD University	2002
13	Edu-Sharing	Campus Content	2004
14	LatitudeLearning	Latitude Learning	2005
15	Nera	Edunera	2017
16	NexusComply Solution	Learning Nexus	2015
17	OLAT	University of Zurich	1999
18	Opentute	Opentute	2018
19	Percolate	Percolate	2018
20	Sakai	Sakai	2005

2.2 eLearning and Hybrid Learning in Tertiary Education

With advances in technology, eLearning has grown to complement traditional classroom learning and is slowly taking up a larger portion of overall learning. eLearning encompasses a wide variety of modes, with the main modes being Blended/Hybrid Learning and Open Pedagogy (Williams 2018). Blended/Hybrid Learning combines the use of face-to-face classroom teaching and learning with online learning components. It is termed as Flexible Learning in the cases where students are expected to read and absorb course materials before attending the face-to-face classes.

Pure e-Learning or Open Pedagogy relies completely on using online resources to complete the learning outcomes. This category includes Massive Open Online Courses (MOOC) which are interactive online courses with open access through the web which are suitable for distance learning programmes.

With the widespread use of mobile devices, a positive development is the availability of eLearning VLEs integrated into digital platforms such as mobile apps and accessed through mobile devices (Gorshenin 2018). Ortiz and Green (2019) studied student mobile device LMS app usage patterns of US students and found that students have embraced accessing learning materials at any time.

2.3 Academic Staff Engagement to Use Virtual Learning Environment (VLE) for Teaching and Learning

There are some researches around the general issues surrounding the adoption of VLE by teaching staff worldwide. Mapopo (2016) focused on recommendations for transitioning from a D2L VLE to Canvas VLE at a U.S. university. Wichadee (2015) studied attitudes of Thai university teachers towards VLEs while Alshammari (2015) looked at academic adoption at Saudi Arabia Universities. Awang et al. (2018) looked at the experience of instructors with Frog VLE in Malaysia. Holmes and Prieto-Rodriguez (2018) investigated perceptions of teaching staff in Australia. Tayşi and Başaran (2018), as well as Alshormman and Bawaneh (2018), covered attitudes and perceptions in Turkey. Raga and Rodavia (2018) meanwhile looked at Moodle VLE perceptions and utilisation in the Philippines. There is very few literature focusing on Hong Kong academic adoption; an example would be Luk, Ng and Lam (2018) who investigated Moodle VLE utilisation in Hong Kong.

The literature shows a difference between perceived and actual use. Academics overall have a positive attitude towards using the VLE in engaging with students but issues such as lack of time, systems weaknesses and mainly acquiring the proper skills to use the VLE effectively were the main issues raised which hindered a fuller utilisation of the VLE resources. Further training in the use of the VLE was recommended in order to address these obstacles.

In summary, although there are some researches on academic staff's perception and utilisation of VLE in general, there is a scarcity of research focusing on the Hong Kong environment and the specific use of the Canvas Virtual Learning Environment in tertiary education. This research aims to fill that gap.

3 Research Methodology

There are several advantages of employing qualitative research methods. First of all, the qualitative research method gives the researchers the ability to understand the human experience in specific scenarios. Secondly, qualitative research methods can facilitate the researchers to discover the individual's inner experience so as to figure out how individual behaviours are shaped through culture context (Corbin and Strauss 2008). Thirdly, the qualitative research method gives the researchers great flexibility in terms of the structure of design (Maxwell 2012). Last but not the least, qualitative research methods such as direct observation and structured telephone interview are widely used methods for data collection (Cohen et al. 2011). This research sets out to investigate how academic staff engagement with the Virtual Learning Environment can be improved. The outcome of this study will be a number of recommendations for increasing academic staff engagement with Virtual Learning Environment when used as part of Blended Learning. The study takes a comprehensive approach by first asking the respondents to fill out a nine-question structured questionnaire and then follow up with each respondent with a more in-depth one-to-one interview via telephone. The researchers sent out questionnaires to all 30 part-time lecturers at the institution through email and eventually received 10 completed questionnaires for analysis. The response rate was 33% which was considered quite good for this kind of research.

4 Research Results and Discussions

Since the research is broken down into two stages, namely a questionnaire survey and one-to-one interview with the respondents, the results, therefore, will be presented separately in different parts of the paper.

4.1 Stage 1: Questionnaire Survey

The respondents were asked, "before using the VLE (Canvas), were you provided with any handbook on how to use it?" The results were mixed since half of the respondents said "YES" and the other half said "NO". 90% of the respondents think that an appropriate level of training could have improved their usage of Canvas. 90% of the respondents were using a web browser on personal computers as their main channel of interacting with Canvas. With regard to the main emphasis on using the VLE platform, 90% of the respondents said that they used the VLE platform to disseminate teaching materials to the students. 40% of the respondents said that they used the VLE platform for letting students submit assignments. 60% of the respondents said that they used the VLE platform for sharing supplementary information such as additional readings or videos to the students. 60% of the respondents said that they did not find a general reluctance from lectures or students on using Canvas. 60% of the respondents indicated that disseminating teaching materials to the students as the most useful function of the VLE. 50% of the respondents did not think that allowing the students more anonymity might improve more usage of the VLE. 70% of the respondents indicated that there were sufficient incentives for the lecturers to use Canvas. In terms of what functions would the respondents suggest adding to the VLE in order to improve the learning experience of the students, the results were very diversified. Please refer to Table 2 for the diversified result.

Table 2. Functions that would improve the learning experience of the students

Respondent 1	Instant messages
Respondent 2	Have checked with students. They found it not particularly helpful as the resources provided lack the necessary depth
Respondent 3	No idea
Respondent 4	Adequate functions already provided by the VLE
Respondent 5	For topics that need action learning or laboratory testing, VLE can play a critical role
Respondent 6	Simulation games on management decision and investment plan (e.g. corporate finance, training and development, talents development and even marketing, etc.)
Respondent 7	Nil response
Respondent 8	let the student see what pages they haven't seen; like a history function
Respondent 9	Easier access through mobile phone
Respondent 10	A 24-hour help desk to help students whenever they encounter problems

4.2 Stage 2: One-to-One Interview

Based on the findings from the 10 completed questionnaires, the researchers conducted a follow-up call to get more information from the respondents. Eventually, the researchers were able to reach all 10 respondents for further information. The respondents were asked how familiar they are with the Canvas' function, 50% of the respondents weighted 3 out of 5 marks, 20% of the respondents think that they were quite familiar with the Canvas function. 30% of the respondents think that they have less familiarity with Canvas' functions. 70% of the respondents didn't know there was a CANVAS Mobile App. Those that knew about the CANVAS Mobile App commented that they never used it before. All of the respondents knew that there were functions like Discussion, Announcement, Chat, Quizzes. However, 20% of the respondents never used those functions and for those who used these before mainly used the Announcement function. Some of the reasons from the respondents for not using those Canvas functions are listed in Table 3.

Table 3. Reasons for not using those Canvas functions

Yes, but seldom used, students need a transition period, agree that Discussions will help student's learning experience. But it will increase the burden from the lecturer
Yes. Seldom used, need to sort the basic and consider if a student uses it or not. Had an experience that students didn't use the discussion/chat function
Yes, but did not use this function. Used Facebook to do all these functions, open group share information, post-YouTube video, blog article
Yes, but did not use at the moment as Canvas is still new to him. He believes that student's learning experience can improve if he uses those functions. However, he only thinks 50% of students will participate
Yes, have used Announcement function, one-way interaction would be useful, but two-way communication functions like Discussion, Chat are not useful as students are not participating. If this can be synchronised with daily communication tools, like Google calendar and Gmail, he believes this will improve the usage from students
Yes, have used Announcements. Want to use Discussion and Chat functions, however, checked with students that they are not all enrolled in the module, therefore, didn't use it before. In her view, students are less willing to participate unless the discussion is around the assessment question; it can motivate the student to participate
Yes, but didn't use these as student seldom participate, students will use other convenient channels to communicate like WhatsApp, e-mail
Yes, but don't think these are useful. Students have their own WhatsApp group discussion. Students prefer sending e-mails to tutor
Yes, but don't know how to use it
Yes, but didn't use. Students only will download materials in Canvas and come to the lecture. Don't think a student would use those function

50% of the respondents were not aware of the detailed manual provided by Canvas online and the 24 h support hotline from Canvas. For those who knew about it, they also seldom availed of these. One of the respondents thought that he could handle the functions being used at the moment without using the manual. Two of the respondents commented that the manual is too detailed and they hesitated to go through all the detail.

The respondents were also asked what kind of training and support would improve the usage of CANVAS. Please find the summary of responses below:

Training:

- Comprehensive training on the use of all general function. (e.g. provide short cuts or different ways/methods of use)
- Two-way communication, privacy message function (if any)
- Face-to-face course induction briefing for new users. Training, for example, on how to deal with technical downtime on the front page, online chat room function for both student and lecturers.
- Using the app is more convenient to view the instant message

Support:

- Need support from staff if there is the difficulty of using the basic function.

4.3 Discussion

The researchers found that in order to motivate the academic staff to engage more on the Virtual Learning Environments, the University should implement a number of different measures as stated below:

- Provide a trial link for a tutor to test the features, provide a quick guide of the feature.
- A simple guide or video to show the common function is sufficient.
- Providing a User's Manual would be helpful.
- More communication to both lecturers and students to encourage the use of Canvas
- If Canvas can synchronise with daily communication platforms, it would improve the motivation of both students and lecturers to use it.
- All students should be registered with the VLE at the beginning of the term.
- Set some online quizzes that count for part of the module mark to encourage the student to use.

5 Limitation and Further Research

Even though this research is a case study, readers need to consider the presented findings within the context of limitations. Since it is a case study, the researchers only surveyed one U.K. tertiary education institution in Hong Kong. Since their Hong Kong Campus was recently established, it only employed 30 active part-time lecturers currently. The researchers already made an attempt to survey the 30 lecturers hence the full population of academic staff employed by the Hong Kong institution. Even though the response rate is 33% which means that the researchers only got back 10 completed questionnaires which make the sample size extremely small, the researchers are well aware that the extent to which our findings can be generalised certainly requires further investigation. Given the above stated limitations, in term of further research, the researchers may survey academic staff from other tertiary institutes in Hong Kong or even interview academic staff from other regions in Asia to make the research even more significant because the process of answering particular research questions typically will generate more questions that need to be explored through further research.

6 Conclusion

This study aims to look at the level of engagement of academic staff at a U.K. tertiary institute education institution in Hong Kong on their use of the Canvas VLE and provide further insight on how the level of engagement could be improved. Initial review of the literature found that there are very few researches on academic staff at Hong Kong tertiary education institutions engagement with VLE particularly involving the Canvas VLE. General research on academics engagement with VLE, in general, showed barriers to a higher level of engagement include academics' lack of time in acquiring the proper skills to fully engage in the VLE's functions, apart from the technical limitations of the VLE.

The researchers investigated the validity of the level of engagement of academics to the Canvas VLE at a U.K.'s tertiary education institution in Hong Kong by sending questionnaire survey to all the local teaching staff at the institution. They were asked if instruction manuals were given to them prior to teaching, what devices they normally use to connect to the VLE, the main purposes for their use of the VLE, and their perceived reluctance to engage in the VLE from teachers and students. Follow-up telephone call interviews to all respondents were conducted to obtain more in-depth responses. The findings from the questionnaires and interviews support the need for more promotion of the VLE to users, provision of a more robust training process for academics on the use of the VLE in the form of a manual and video and a face-to-face briefing session, a trial link to a site where academics are able to explore the different functions of the VLE, and incorporating tasks for students to engage their use of the various functions of the Canvas VLE. Finally, further research could be considered to obtain a larger sample size to obtain a more representative and statistically robust result.

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Teaching Mathematics Among Students with Learning Disability: Non-technological and Technological Approaches

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Abstract. A learning disability (LD) is a problem affecting how a student cognitively receives and processes information. Students with this condition may have trouble with learning skills including reading, writing and calculation. Therefore, it might be pedagogically inappropriate to adopt typical approaches with other students to teach LD students. This paper examines various approaches to teaching mathematics among LD students, covering both non-technological and technological. It points to the importance to integrate both approaches to make learning of mathematics among LD learners more effective. It is believed that technological tools are more engaging to students who have a short span of learning attention and those who need more aids for visualisation to learn. However, these have to be utilised appropriately based on the principles proposed by the non-technological approaches such as CPA, 3R and Task Analysis.

Keywords: Learning disability · Mathematics education · CPA · 3R · Task analysis

1 Learning Disability in Mathematics

A learning disability is generally defined as a person who has a limitation of learning in the area of reading, writing, and calculation. Students with this condition can be explicitly noticed since primary 3 by comparing their relatively lower level of achievement against the national standard criteria. However, this is not evident in the lower grades, i.e. primary 1 and 2 [21]. The major cause of LD is believed to arise from a neurological abnormality in the brain structure and function. The side effects vitally reveal its conditions in an early developmental stage. Some students with this condition can intelligently perform with outstanding or above-average scores [2]. Thus, potential critical learning points could possibly occur in each of the students' cognitive developmental processes.

In mathematics, calculation is shown to be the main issue of learning disability which is often referred to as dyscalculia. Children who are dyscalculia tend to fail to create abstract representation when dealing with numbers. For example, compared with students in the same grade, LD students are not fully able to count without using their

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fingers. Others may have trouble to understand mathematical symbols or get confused with place value. With these issues in mind, there are no medications for dyscalculia, and thus many LD students are struggling for achievement. Therefore, it is believed that the only "prescription", for this is supposed to be an appropriate learning process.

1.1 The Difference Between Dyscalculia and Difficulty in Mathematics

The overlap between dyscalculia and difficulty in mathematics is suspected. In the classroom, an achievement score becomes the main criterion used for classifying students' ability as per the suggestion from The Royal College Pediatricians of Thailand [21]. However, we argue that low achievement can result from either dyscalculia or difficulty in mathematics itself, or both. To avoid misunderstanding leading to misclassification of students' learning ability, it is necessary to distinguish between dyscalculia and difficulty in mathematics. According to Kosc's studies [12], dyscalculia is understood as a learning issue driven by biological factors of individual learners; one of which is the ability to process numerical representation such as knowing a magnitude of each number and understanding the meaning of simple operation in arithmetic [18]. This mental disability might not only show in school but also affect daily life such as buying items in grocery stores or remembering a phone number.

In contrast, difficulty in mathematics is caused by the complication of the subject itself, coupled with environmental and emotional factors including ineffective instruction, emotional trauma, and social pressure. Students feel behind in mathematics when they perform poorly in mathematics test and then they try to avoid any effort to do mathematics. Also it is undeniable that when facing tasks that exceed cognitive thresholds and the mental load is also exceeded, students tend to be unable to process or retrieve information appropriately. This symptom is called mathematics anxiety which could potentially be reduced by relaxation [16].

2 Non-technology Based for Teaching Mathematics

A common challenge in learning mathematics is associated with the abstract nature of the subject. Mathematical abstraction is shown in the forms of symbols, variables and numbers. All of which can bring negative feeling towards doing mathematics as they are complex and difficult to make interpretation. Therefore, for average students, it is necessary to make these abstract concepts concrete enough for learners to build their own mental representations. Of course, the same has to be done for LD students, despite the fact to keep in mind that they tend to have difficulty in grasping anything abstract. This paper reviews three pedagogical approaches for teaching mathematics and for dealing with LD learners. It argues that there is no need to choose one over the other. Different LD students have different challenges. Therefore, it is important to understand all of these and apply them appropriately. In sum, this paper argues that the most appropriate approach to make LD students understand the abstract nature of mathematics is through CPA which stands for Concrete, Pictorial and Abstract (Sect. 2.1). However, each lesson has to be digested to its simplest forms via Task Analysis (Sect. 2.2) in order for LD students to proceed from one to another until they complete the whole task. Finally, in each of the tasks that they proceed, it is important to walk with them through the 3Rs which stands for Repetition, Relaxation and Routine (Sect. 2.3).

2.1 CPA (Concrete, Pictorial, and Abstract)

On basis of the fact that abstraction cannot be reached without being able to draw a connection to a concrete object, or visualise a concrete representation in mind [17]. This approach therefore begins with providing physical models or concrete objects, called manipulatives, to make a mathematical scenario tangible to learners, known as a concrete (C) stage. Then mental work is continued to challenge by a pictorial stage (P) in which learners put attempt to use and make visual representations to draw pictures to model a given problem. The progress from C to P prepare learners to arrive at an abstract stage (A) in which students are able to construct an abstract representation without concrete or pictorial aids and this is considered to be the most advanced form of mathematical learning and understanding.

One study shows the comparison of students' learning outcomes between those in a traditional classroom in which instruction rests solely on mathematical symbols and those in a classroom where students are exposed to mathematical manipulatives [1]. Their result conveys that the mean score of those using manipulatives was statistically higher than that of those in the traditional classroom. This CPA approach has been found to be useful among LD students likewise. LD students can manipulate concrete things in order to develop a conceptual understanding such as fraction circle, tiles or base-10 blocks [5].

The empirical data points out that teaching about place value among LD students based on CPA is more effective than abstract teaching. Moreover, the increase in skill acquisition, maintenance, and retention is the result of using concrete manipulatives [18]. Furthermore, the effectiveness of CPA in medicating the effects of impairment in basic mathematics calculation of LD learners is evident. A similar result is also shown in [24], that after LD students studied how to solve algebra equations through CPA, they outperformed their peers who received traditional instruction.

Although CPA has been proven effective for using with LD students, along the implementation stage, it still needs classroom management strategies that can help the instructional approach run smoothly. Two techniques for teaching LD students are provided in this paper in order to show that even though there exists an effective mathematics teaching approach, there still are some concerns like the frequency of using it, atmosphere in classroom of LD students, an appropriate task for LD students, among others.

2.2 Task Analysis

Task analysis is a process of breaking a target skill down into smaller parts that are easy to achieve. Arranging the task from easier to harder ones would help students proceed gradually with greater challenges as the lesson proceeds [20]. This can identify into six steps are given in Table 1.

Mathematical problems require multiple steps to solve. Task analysis can help teachers digest the principal task to small processes that are interrelated [7]. Then students can solve each of the smaller processes gradually in order for the principal task to be achieved. Doing so not only helps students work on the solution step-by-step, but it also helps learners gain more confidence when they proceed from one to the next. Students tend to give up easily if the task appears to be too challenging to them, not to mention LD students. Therefore, small successes that they can accumulate throughout their learning journey would motivate them to learn and build on stronger self-efficacy in learning.

Table 1. Task analysis: six steps of doing a task analysis

Step	Tasks to do
1	Identifying the target skill
2	Identifying the pre-required skills and materials needed in that task
3	Breaking skill down into small tasks
4	Making sure that each task is accurately represented a target skill
5	Choosing the appropriate teaching approach with each task
6	Implementing a teaching approach and observe progress

2.3 The 3Rs

Knowing that LD students are those who need special attention and treatment, the 3R approach suggests a direction in which any instruction should proceed [3]. Due to the fact that LD students tend to be relatively slower when processing information, it is important to repeatedly explain something to them. Therefore, the first R stands for Repetition which is a process of teaching about one thing repeatedly and spends more time to elaborate the content to LD learners compared to their peers who tend to proceed well. It is true that special attention commonly comes with pressure on the one who is being treated. Therefore, the second R comes to its place and that is Relaxation which can be done through other fun activities including recreations alongside the repeated instruction in order to reduce unnecessary stresses. Finally, LD students are prone to struggle with changes and thus it is crucial to help get them familiar with a particular pattern before trying something new. This leads to the incorporation of the third R which stands for Routine with the aim to frequently adopt learning activities that have to same learning pattern.

Studies show that after LD students practiced reading the Thai language using the 3R teaching approach, students' reading ability increased substantially based on a national standard criterion [11]. In the same way as Liangphan's study whose statistical result significantly reveals that skill in the area of counting 1–10 among LD students improved after being taught with 3Rs [14]. In sum, the learning environment that provides repetition of learning tasks, relaxing interaction between learners and teachers as well as among learners themselves, and routine delivery of certain activities helps ease learning of LD students, although the subject keeps changing from class to class.

This highlights that once the learning approach (3Rs) remains constant no matter what the content is about, LD students tend to feel more comfortable and be more open to new concepts which in turn leads to better learning achievement.

3 Technology-Based for Teaching Mathematics

To make a learning process more effective, bringing technology in classroom considered an alternative for teachers. This seems to be one solution for decreasing limitation which happens from the non-technology based approaches mentioned above. With the main point that technologies can help LD students improve their learning and facilitate learning in any direction they possibly would like to [15]. Research points out the importance of having technologies in education that they serve as tools for supporting students to access information actively and independently according to their needs [23]. This personalised learning environment is found to be useful for various groups of students including LD learners who could follow lessons progressively. According to the principle of personalized learning, learning can be assisted by an adaptive technology that is used in order to support teaching and learning [22]. An empirical study points out that the use of adaptive technology has a positive impact on students' achievement in many subjects [8]. Moreover, the finding of Fry [9] shows that after taking a personalised approach with technology, all individuals with LD conditions are more independent, enabling them to make more choices and take more control over their own lives. Of course when LD learners are able to follow the class like their classmates, they tend to gain more confidence which is a positive signal of learning. In addition, technologies assist their individual life because technologies in education have a range of devices which LD students can utilise on a daily basis [13]. For example, those with dyscalculia can use a calculator to calculate price in a supermarket. In addition, those with reading difficulty may use the aid from an application to read out texts so that understanding can be established through listening instead of reading.

Technologies can come into play in various parts of mathematics teaching. However, the emphasis of this paper is on the integration of technology in education using the CPA approach. As the initial step for teaching mathematics is to provide LD students with concrete materials, physical objects or other forms of manipulatives. The difficulty of teaching in this stage is about selecting these tangible objects for LD learners. Finding materials is one thing. Making these tangible materials tangible in the mind of LD learners is another thing. There are times when concrete objects that are provided do not always make clear their mental representations. Of course this hinders them to proceed to the next stage. However, a laptop computer and mobile devices including tablets and smartphones can install a great variety of virtual forms of concrete objects as well as pictorial representations. Some of which are animated and colourful which can help LD learners visualise any abstraction more effectively [5]. This fact is proven true in our data collection. We initially prepared various sets of concrete objects to LD students. However, the students did not seem to engage with the concrete objects we used. So, we had to ask them what actually come into their mind at the moment, then we continued using the concrete and pictorial representations that are said by the students to proceed the lessons. We learned that each of the LD students can never have to same concrete representation, even though the same thing is mentioned. Of course, without the aid of computer and mobile technologies, we would not be able to manage to have concrete representations for students. Such technologies provide instant access to pictures, animations. Also, with the coming of Augmented Reality, it opens wide opportunities for LD learners to learn abstract concepts more easily.

3.1 Computer-Based Virtual Manipulatives

A computer-based approach focuses on interactive elements of computer software which present various forms of information or media to the students. LD students can learn any materials through a computer with their own pace. This is shown to increase learning ability in mathematics among LD students [4]. As simple as a recorded video using anchored instruction, LD students have shown their significant improvement in solving mathematical problems and computing fractions through this medium of learning. Their post-test score in computing fraction questions statistically improved after participating in the computer-based instruction.

Benefit of using computer-based instruction for LD students especially in mathematics is also found in an empirical study [10] which develops a computer-based software program to help students construct a sense of factual number and become fluent in computation single-digit of mathematics operation: addition, subtraction, multiplication, and division. The software provides a set of problems with different levels of difficulty an immediate feedback will be automatically given to the students as they finish a certain task. Not only the answer and the solution to the question, students are given timed fluency as feedback in order from them to improve their speed practice alongside accuracy. The result of this study shows that those being exposed to the learning with this computer-based instruction outperform the other group of students who receive a traditional instruction.

3.2 App-Based Virtual Manipulatives

Using a computer-based instruction might not be practical in many classrooms especially the issue of portability. Thus there has been an increase in using applications installed in mobile devices as learning tools. Apart from their portable use, the internet is not required once applications are completely installed in a mobile device. Many app-based manipulatives can support both IOS and Android operation systems. Although there is a period for upgrading, this does not interrupt continuous work because no software update is required [5].

Moreover, app-based manipulatives have been applied to use in mathematics, students are able to interaction by touching from the screen of the device. Touching is an important action in the manipulation process. This is due to the fact that while students are touching a virtual object on the screen, imaginary and mental simulation are cognitively promoted in the process [6]. Students will gain experience similar to the real interaction using these virtual forms of reality. In addition, app-based manipulatives also help teachers prepare their lessons with ease since app features can be edited as required [5].

Comparative study shows that LD students being exposed to concrete manipulatives outperformed their LD peers who learned through virtual manipulatives accessed from the National Library of Virtual Manipulatives (NLVM) website in solving mathematical problems related to a single-variable linear equation, although both groups of students improved their learning achievement after learning through their assigned modes of manipulatives [19].

4 A Synthesized Instructional Model for LD Learners

This study points out ways in which LD students can learn mathematics more effectively, consisting of CPA, Task Analysis and 3Rs. It therefore proposes an instructional model for LD learners to learn mathematics through the synthesis of compounding three teaching approaches which would simply explain within one approach with slight modification.

It is believed that the most effective learning mathematics strategy for LD students is the CPA approach which firstly beginning with using concrete manipulatives (C) in order for LD students to be able to visualize tangible things and construct new knowledge from the received information. Then they should be allowed to think of any pictorial information (P) using pictures or drawings in order to generate understanding of mathematical conceptions. It is important to note that, first, these two stages can be benefitted from the use of educational technologies including computers, the internet and applications. Second, these two stages are not linear, meaning that some students may not start from learning through a concrete object but jump to thinking of a pictorial representation. However, there are times when they have to shift back to work on something concrete interchangeably. Meanwhile, there might be some who can skip the pictorial stage and reach the level of abstract once they get used to a concrete phenomenon. Ultimately, the aim for teaching a mathematical concept is for LD students to build abstract understanding which is considered the most challenging. However, it is assumed that with the strong foundation of the C and P stages, the C stage can be proceeded with minimal challenge (Fig. 1).

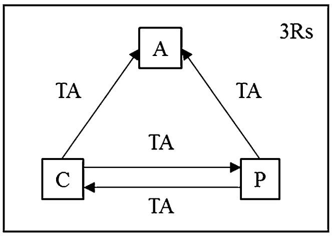

Fig. 1. The synthesized instructional model for teaching mathematics for LD students.

Here comes the role of Task Analysis and 3Rs, in order to know when is an appropriate time to pass from one stage to another, Task Analysis can help determine. That is an attempt to digest the complicated task into smaller and simpler tasks, and help LD students succeeded each of the simpler tasks step-by-step to gain their confidence and understanding according to their learning ability. Furthermore, it is also worth bearing in mind that misunderstanding in any conceptions is not an expectation of learning process, but it certainly does occur, especially with students who hold a misconception from their prior experiences. This places great emphasis on doing Task Analysis along the CPA processes. Simple observation of a performed task can help the teacher evaluate if LD students need more repetition of the same mathematical task, or can proceed to the next stage. In this approach, the teacher has to set a skill set needed for LD students to show. Once it is completed, the students can move on to another task. Task Analysis can come within each of the PCA stages as well as in its transition for one to another. Finally within the stage of CPA approach and the transition from one to another stage, LD students need extra treatment with repetition, relaxation and routine tasks according to the suggestion of the 3R model. Medical research reveals that repetition helps thicken a white, fatty substance called myelin of the neuron which helps learners proceed information more quickly and this is believed to be the cause of slower learning processes among LD students. Relaxation can peripherally assist learners to become more emotionally ready to learn and participate in class activities. In addition, routines are important to LD learners as it allows them to navigate the continuous challenge of learning new things from the safe and comforting boundaries that are created which in turn makes them feel more confident in facing other challenges.

5 Conclusion

There are various reasons that students struggle with mathematics. Some may arise from the difficulty of the subject itself. However, some may be caused by biological factors. Both prominent causes require different remedies to handle. This paper focuses on those struggling to learn due their learning disability. It highlights that LD learners can potentially develop their learning of mathematics through a synthesized instructional model which integrates the usefulness of the CPA, Task Analysis and 3R principles, coupled with the use of educational technologies such as computers and mobile applications. It points out that virtual representations can promote abstract concepts among LD learners. In addition, the aid of technologies can reduce the workload of teachers in preparing concrete materials which sometimes can be difficult to find. However, it is noted that concrete manipulatives are relatively more effective than virtual manipulatives. Therefore, there is no intention to claim which one is best or better than the other. It is up to different teachers who know their LD students the best.

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Cultivating K12 Students' Active Learning and Enhancing Engaged Learning Through Content Creation

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Abstract. Active learners can learn more effectively, have higher motivation to learn, and gain better results. How to cultivate learners' active learning attitude and enhance their engagement in learning is the key. Through a 2-year study of two Chinese classes at a primary school in Panyu, China, we found that learning activity design was the core element in enhancing learners' engagement in the participation of content creation and thus cultivating their active learning attitude to achieve better Chinese performance. This paper fills research gaps in both identifying the role of learning activity design in the process of cultivating learner's active learning and extending content creation from a single step to a process of creation, evaluation and recognition.

Keywords: Active learning · Engaged learning · Learning activity design · Blended learning

1 Introduction

Active learning is to engage students during a learning process through pedagogical methods (Prince 2004), which is often different from passive learning in the traditional, lecture centric instruction. The call for active learning is due to the urge of our modern, competitive society, which requires people to think critically and dissecting information to solve various problems productively (Grabinger and Dunlap 1995) and it is generally accepted that the active involvement of students can better motivate students and enhance their higher-order cognitive skills (Fish 2007).

In addition, content creation, generally referred as the content that is initially created by the learner, is accepted as a way to engage learners to have a deeper understanding of the subject matter and more effective communication (Mitchell et al. 2004). Moreover, content creation in a discussion forum is, in fact, an asynchronous and cooperation mode that promotes cooperation, interaction and mutual motivation through recognition (Lee 2009; Armstrong and Retterer 2008; Campbell 2003). We regard content creation as a process involving creation, reflection, and recognition.

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Although there were a number of research outputs on active learning through online discussion forums, few papers tried to discuss the positive impacts brought by the blended application of the mentioned tools on learners' performance. In this paper, we aim to identify the key methods to measure the engagement level in content creation, the role of learning activity design in the active learning environment, as well as the conditions to facilitate active learning. The study was conducted using activity logs generated from the e-schoolbag system. Eighty-eight grade-four students in the year 2015/16 and forty-two grade five students in the year 2016/17 of Shaxuyi Primary School in Panyu, China, were studied regarding their Chinese performance.

A literature review is summarized in the next session. Then, the case study, corresponding findings, and discussion follow. Contributions and conclusions are summarized at the end.

2 Literature Review

2.1 Definition of Active Learning

Chickering and Gamson (1987) pointed out that students do not benefit from just listening and memorizing learning materials. On the contrary, learners need to be more active in higher cognitive tasks like "analysis, synthesis, and evaluation" (Bonwell and Eison 1991, p. iii). Although active learning is generally accepted, different authors and educators have different interpretations (Bonwell and Eison 1991). Bonwell and Eison (1991) defined it as the activities that "involve students in doing things and thinking about what they are doing" (p. 2). Braxton et al. (2000) elaborated the idea to "activities include discussion, questions faculty ask students in class, co-operative learning, debates, role-playing, and the question ask on course examinations" (p. 571). Prince (2004) explained the various forms of active learning, i.e., collaborative learning which focuses on student interaction, cooperative learning which emphasizes on cooperation rather than competition, and problem-based learning which leads to the development of new knowledge with active participation by students (Miliszewska and Horwood 2006).

The critical challenge in cultivating active learning lies in engaging learners in the learning process (Little 2001; Reinders 2006) and requires teachers' intervention in enhancing learners' engagement (Benson 2001). Hence, a learning environment supporting cooperation and communication should be provided (Little 2009) in order to facilitate active learning. Auster and Wylie (2006) suggested that, from an educator's approach, active learning should incorporate students' feedback to improve teaching and learning continuously. Recently, educators have been complementing active learning through more modern pedagogical paradigms like flipped learning (Patterson et al. 2018) or modern technology like online discussion forums (Mokoena 2013).

2.2 Active Learning in Online Discussion Forum

The discussion forum in e-schoolbag, which is used by the entire class or small groups, promotes interactive and collaborative learning (Lee 2009). The discussion forum is asynchronous in nature such that content and knowledge can be constructed and discussed by learners as a joint effort (Armstrong and Retterer 2008; Campbell 2003). This could be a more effective means than the face-to-face discussion because of the flexible participation and contribution to the discussion (Andresen 2009).

The discussion forum provides chances for learners to think, reflect, and post independently. Learners first conduct an information search based on teachers' guidance and instructions. The content and knowledge are then consolidated by the individual learner or a group of learners depending on the assignment nature. Eventually, the content is posted to the discussion forum. In this study, we measured this type of post as the number of responses in the discussion forum of the e-schoolbag used.

Gamification is another technique frequently used in enhancing learners' engagement in a blended learning environment (Hamari et al. 2014). Being recognized, appraised and rewarded by peers and teachers can enhance learners' social status and satisfaction and thus enhance learners' motivation to participate more in the learning process (Simões et al. 2013). Such greater social presence was found to further increase the effectiveness of the discussion forum (Mokoena 2013). In this study, we measured this type of recognition as the number of flowers in the discussion forum of the e-schoolbag used.

2.3 Active Learning with Content Creation Process

Content creation is defined as "the contribution of information to any media for an end-user/audience in a specific context" by Moonaghi and Shariati (2018), p. 2. Haraldseid et al. (2016) suggested that students' active involvement in creating learning content could benefit students' five different learning needs, such as recognizing a bigger picture and receiving context-specific content. Students were expected to be more aware of the relationships among different knowledge while constructing the content (Kiili 2005). All these factors are in accordance with the aims of active learning to enable students to think critically and to be more engaged. Together, we define content creation as a process which involves the creation of a post in a discussion forum, the opinions that one provides to others, and the recognition received.

Although the success of active learning lies heavily on the learners, guidance by teachers, feedback, and recognition from classmates and teachers are essential in the process of content creation on a discussion forum as Mason (2011) stressed that insufficient moderator participation and inadequate explanation were the pitfalls of students' lack of motivation to participate. Thus, learning activity design plays a critical role in guiding and motivating learners to participate and engage in the content creation process in the discussion forum with the help of the e-schoolbag system.

3 Case Study

3.1 Methods

The flipped classroom complementing with an online discussion forum is the fundamental pedagogy used by the primary school under investigation in this study. The usage rate of the discussion forum in the e-schoolbag, which was the main collaborative platform for sharing knowledge and content creation, and the academic performance in the Chinese subject of two classes at Shaxuyi Primary School (Shaxuyi) in Panyu, China, were studied. Data generated by grade four students (two classes with a total of 88 learners) in the school year 2015/16 and grade five students (one class with a total of 42 learners) in the school year 2016/17 was included in this study.

The involved teachers designed the corresponding learning activities to encourage learners to participate and engage in the content creation process before, during and after classes.

Before classes, teachers can encourage student participation through compulsory activities in the e-schoolbag system, such as requiring each learner or each small group of learners to do information searches and consolidation using the discussion forum before the class. Teachers, as well as the learner and other classmates, can give comments, suggestions, and recognition through positive wording and flowers as recognition. Motivation and engagement are gained through self-reflection and being commented on and evaluated by others (Ryan 2000) and thus cultivate learners' engagement.

During the class, teachers can show some of the contents to the class by the real-time projection of the e-schoolbag discussion forum or invite learners to present their content in front of all their classmates. Teachers and classmates can give comments in the class. All this kind of peer-to-peer or teacher-to-learner recognition can further motivate learners to engage in the content creation process.

After classes, teachers can suggest discussion topics to trigger learners to further discuss, create or modify the content, or even explore other content creation outside the original teaching syllabus. This can continuously encourage and motivate learners to actively involved in their learning and creating content based on their existing and newly acquired knowledge.

In this study, we measured the effect of active content creation, assisting content creation and recognition of content creation as the number of responses, the number of opinions and the number of flowers received, respectively, in the discussion forum from the activity log of the e-schoolbag system. Such data was then compared with the final examination results, which were categorized into gradings, i.e., grades A (marks greater than or equal to 90), B (marks greater than or equal to 80 but below 90), and C (marks below 80).

3.2 Learning Activity Design of the Classes Under Investigation

Instead of teaching the Chinese subject using traditional classroom instruction, the teacher introduced the flipped classroom with the help of the e-schoolbag system to conduct the grade four Chinese classes in the year 2015.

Teachers gave guidelines and reading materials in the discussion forum of the e-schoolbag system. Learners were required to search for information, read other learning materials and sometimes conduct group projects before classes and were encouraged to participate in the forum discussion actively. Feedback by classmates and teachers was provided to improve the knowledge creation process further. During the class, teachers played the role of a facilitator to induce discussion in the classroom in order to fill up the knowledge gaps. Learners and teachers continued the discussion after class.

The discussion forum in the e-schoolbag system is used for discussing various topics in the learning of Chinese. For example, learners may post their understanding and feelings after reading a book or their findings such as comprehension skills. Classmates and teachers may offer supplements, discuss topics, encourage each other and make comments. Authors can add updates, learn more, and gain confidence throughout the process.

3.3 Adjustment of Learning Activity Design

After gaining an initial understanding of the relationship between active learning and academic performance in the school year 2015/16, teachers believed that learners' engagement in the content creation process in the discussion forum could cultivate active learning among students and thus improve learners' academic performance. In addition, teachers also believed that learning activity design is a key factor in encouraging learners to engage in the content creation process. Therefore, the teacher further adjusted the learning activity design inside the flipped classroom pedagogy in the school year 2016/17 in order to cultivate an active learning environment in the class that she taught.

To further encourage active learning, the teacher's role is to ask learners to search the internet for knowledge and exciting materials, take part in competitions, read more materials in addition to the textbooks, etc. (Kavaliauskiene 2002). The teacher designed an interesting topic each week and gave sufficient time for learners to form small groups and conduct information exploration before classes. In addition to discussing in the forum before classes, each group has chances to present their findings in the class to gain real-time feedback, encouragement, and suggestions for improvement from classmates and the teacher. These encouraged learners to speak aloud, speak in front of people, reduce their fears and enhance self-confidence through small achievements.

Chances should be given to learners to swap places with teachers, which provides learners the opportunity to assess themselves and assess other learners (Kavaliauskiene 2002). The teacher encourages learners to participate actively in the forum discussion not only to post their own findings but also to review and comment on findings from classmates. In the classroom, learners are encouraged to comment on presentations given by classmates. Through assessment of others' or sometimes even one's own posts, learners' engagement and independence are enhanced.

3.3.1 Findings in 2015/16

From the data generated in the school year of 2015/16, Table 1 shows the distribution of average system usage (number of responses, number of opinions and number of flowers) against the grades of the Chinese subject.

The two classes are roughly evenly distributed in terms of the number of students in each grade although Class 2 had slightly better performance than Class 1. This is because of the random assignment mechanism of classes when a new learner is admitted into the school while the ratio of the number of students per class, gender, and minorities are preserved.

Table 1. Distribution of average system usage against the Chinese Grades

Grade	Class											
	Number of learners			Average response			Average opinions			Average flowers		
	Both	1	2	Both	1	2	Both	1	2	Both	1	2
A	53	25	28	43.25	19.16	64.75	16.56	16.32	16.78	148.87	67.56	221.46
B	27	14	13	23	17	28.77	10.74	12.86	8.46	78.19	38.43	121
C	8	3	5	20.5	**21**	20.4	10.5	**16.67**	6.8	57.88	30.67	74.2

It can be observed that all the measured values dropped across grades, except Grade C of Class 1 due to the exceptionally small number of samples. That is the higher the usage, the higher the grade.

3.3.2 Findings in 2016/17

While comparing statistics between 2015/16 and 2016/17 for Class 1, Table 2 shows the distribution of average system usage (number of responses, number of opinions and number of flowers) against the grades of the Chinese subject in the two school years correspondingly. Similar observations as those in the year 2015/16 can be observed for the year 2016/17 with the exception of the three students in Grade C. Another observation is that the majority of the measurements increased and the number of high-grade students increased correspondingly.

Table 2. Statistics for Class 1 between the year 2015/16 and 2016/17

Grade	Number of learners		Average responses		Average opinions		Average flowers	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
A	25	34	19.16	40	16.32	29.03	67.56	95.24
B	14	6	17	28.33	12.86	15.67	38.43	27.17
C	3	2	**21**	**39**	**16.67**	**17**	30.67	**38.5**

4 Discussion

4.1 The Positive Impacts on Learners' Performance

From the analysis of the data in the year 2015/16, three positive impacts on learners' Chinese performance were identified:

- The learners' Chinese performance was enhanced under active learning in content creation. From the statistics obtained in the year 2015/16, Grade A students have obviously a higher average number of forum responses which means more posts/content being created. This can be observed in each individual class or by combining the two classes as a whole. Grade B has a medium average number of forum responses in Class 2 and both classes, except Class 1 due to the small sample size and other reasons to be discussed. Students' engagement is directly related to the cognitive, social and affective dimensions of language learning (Little 2001; Reinders 2006). Content creation in forum discussion reflects the activeness of learners because learners are actively engaged in searching for information and knowledge, solving problems, developing ideas and producing the content to be posted. Therefore, adjusting learning activity design to engage learners in content creation in the discussion forum further is essential.

- Self-reflection and assisting content creation improved the students' Chinese performance. Similarly, providing opinions is another kind of content creation first by assessing the content provided by classmates and then providing comments or other ideas. On top of being treated as part of the content creation process, it also gives a chance for each learner to communicate and assess their own/others' work openly and good opinions can yield recognition from others. Teachers' comments and encouragement are important in the process as well. These further enhance the engagement and thus cultivate the active learning environment. The statistics in the year 2015/16 on the number of opinions have a similar pattern as that of the number of responses. This further affects the learning activity design on how to increase learners' engagement by providing opportunities to assess oneself and others.
- The students' Chinese performance was enhanced by gaining recognition through content creation. Recognition, by receiving comments or flowers quantitatively, further enhances self-confidence and thus the engagement and learners' participation. The statistics in the year 2015/16 on the number of flowers have a similar pattern to that of the number of responses and number of opinions. This further affects the learning activity design on how to increase learners' self-confidence through small achievements.

4.2 Cultivating Active Learning Through Adjusting the Learning Activity Design

While knowing the effect on active content creation (measured as the number of responses), assisting content creation (measured as opinions) through assessment, and recognition of content creation (measured as the number of flowers) can reflect how active the learners are and positively associate with their Chinese performance, so learning activity design becomes the key to increase the engagement of learners in the content creation process in the discussion forum.

The adjustment of learning activity design in the year 2016/17 positively increased the engagement in the content creation process for most of the students. It shows that if the technology is well considered and included into the instructional design, students' engagement, as well as the quality of the content being created, can be enhanced and learners can receive more recognition from peers. Hence, active learning attitude can then be cultivated.

4.3 Exceptional Cases

The three learners in Class 1 continuously received the lowest grade in the class despite the adjustment of learning activity design. Only one of the three improved through the adjustment of learning activity design which helps to develop learner's participation through content creation.

Through qualitative analysis in a post-meeting with the teacher, the major reasons for the majority of Grade C learners are related to family backgrounds such as parents' education level and parents' time for the family, financial situation, or learners' health issues that are beyond the intervention of the school and teachers.

5 Contributions

The findings of this paper contribute to the active learning research area in the following ways:

- Content creation can be treated as a process involving creation, assessment, and recognition: content creation is normally regarded as creating content or knowledge. Rare studies discuss the impact on the effect of giving opinions on content created by oneself or others and the impact on the effect of being recognized. This paper fills this gap by proving that active learning is not only cultivated and developed through content creation but also through the whole content creation process from learning activity design, content creation, assessment, reflection, to recognition.
- Learning activity design is important in the process of cultivating learners' active learning through content creation: content creation without a specific purpose, proper guidance, careful planning, and evaluation is not sufficiently useful. Rare studies explore how the content creation process should be guided in order to be effective in cultivating active learning. This paper fills this gap by proving that learning activity design is important in cultivating active learning through the content creation process.

6 Conclusion

Learners with higher involvement can learn more effectively, have a higher motivation to learn, and gain better results. Content creation is regarded as a motivated learning process to cultivate active learning and to enhance learners' knowledge. Discussion forums, with the help of technology, have become a common collaborative platform in most schools to facilitate content creation and knowledge transfer.

We studied two years of data from two classes at a primary school in Panyu, China. The content creation process including content creation, assessment and being recognized was found to be positively associated with learners' Chinese performance. Learning activity design was found to be the core element in enhancing learners' engagement in participating in the content creation process and thus cultivating their autonomy and thus their Chinese performance. It also points out the importance of instructional design in cultivating active learning in content creation. This aligns with our previous research, using the same school's blended learning environment but with a different set of data, which points out the importance of instructional design in cultivating active learning attitudes, influencing learning behaviors and affecting academic performance (Hui et al. 2018)

This paper fills research gaps in both identifying the role of learning activity design in the process of cultivating active learning and extending content creation from a single step to a process involving content creation, evaluation and commenting on the content created, and being recognized.

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Intercultural Comparison of E-Learning Behaviors of Chinese vs. American Students

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Abstract. This paper focuses on E-learning and intercultural studies of Chinese and American students. The paper is divided into six sections including Introduction, Intercultural Comparisons of Chinese and American Students, E-learning, Instructional Design for E-Learning, Cultural Theory for E-learning, and Conclusion. As a practical result, this paper is useful to researchers and practitioners who wish to know and understand cultural differences and E-Learning behaviors of Chinese and American students. This knowledge could enhance online teacher-student interactions, improve E-learning outcomes, and identify salient cultural communication differences.

Keywords: Chinese and American Students · E-learning · Instructional Design for E-Learning · Cultural Theory for E-learning

1 Introduction

This section begins by defining key terms for the study, including E-learning and intercultural studies. According to Sangra, Vlachopoulos, and Cabrera (2012), an inclusive definition of E-learning includes four categories: technology-driven, delivery-system-oriented, communication-oriented, and educational-paradigm-oriented. The authors defined E-learning as "representing the educational model applied, that is based on the use of electronic media and devices as tools for improving access to training, communication and interaction and that facilitates the adoption of new ways of understanding and developing learning" (p. 152). Intercultural studies are about how students from distinct social groups or cultures exchange information or interact in certain ways (Triandis 1989). Culturally responsive teaching is defined as "using the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively" and can improve learners' experience in today's multicultural education classroom (Gay 2002, p. 106).

According to Wang (2007), cultural identity and communication styles strongly influence students' E-learning behaviors, engagements, and interactions. Cultural identity is the primary culture in which an individual grew up (Wang 2007, p. 4). Through my Chinese American background and experience teaching both American and Chinese students in E-learning classrooms, I have observed that most American students are bold in class; they ask questions and are comfortable with online discussion boards. In contrast, most Chinese students are more reserved and nervous with online discussions; they often find it difficult to express their opinions in writing

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because they are used to communicating face-to-face with peers and instructors, but in the Chinese educational system they are discouraged from stating their own ideas in writing.

2 Intercultural Comparisons of Chinese and American Students

This review paper compares Chinese and American students' E-learning behaviors for instructors to improve their E-learning curriculum development. To understand E-learning and cultural effects on Chinese and American learners, it is imperative that we first understand good practices that affect learning in the general sense. There are seven good practices in undergraduate education and instruction:

1. Encourage contact between students and faculty;
2. Develop reciprocity and cooperation among students;
3. Encourage active learning;
4. Give prompt feedback;
5. Emphasize time on task;
6. Communicate high expectations; and
7. Respect diverse talents and ways of learning (Chickering and Gamson 1987, pp. 3–5).

The last practice, respect diverse talents and ways of learning, is evident in classroom environments and fosters good academic behavior. There is some evidence that Chinese and American students learn differently (Andrade 2006; Bista and Foster 2011; Chen et al. 2008; Wan 1999). One approach to understanding how Chinese and American students might think and learn differently is based on the differences between Confucian (Eastern) and Socratic (Western) approaches.

As the primary educational models used by Eastern and Western cultures, a comparison of the Confucian and Socratic approaches may unpack the influence of culture on learning styles. Gorry (2011) describes how Chinese and American learning styles differ due to Socratic and Confucian approaches. Chinese students learn the Confucian approach in their schooling, which Gorry (2011) describes as "a didactic teacher-centered pedagogy with a greater emphasis on strategic and direct thinking" (p. 4). In the Confucian approach, the instructor serves as a manager and an authority figure. Students tend to be surface-level processors, i.e. memorizing knowledge and material without questioning the sources.

However, the Socratic approach is based on "an experiential learner-centered pedagogy that values creativity and intellectual independence" (p. 4). For the Socratic approach, the instructor is a facilitator and a midwife (p. 6). Socrates's mother was a midwife, and he used this analogy as a model for education: "as a 'midwife of ideas', helping others to bring forth ideas, but not himself giving birth to ideas, in the same way that a midwife helps a woman to give birth without interfering too much in the birth process" (Vivilaki and Johnson 2008, pp. 90–91). The Socratic approach is also associated with individualistic Western culture explained by Hofstede's cultural dimensions theory (Kang and Chang 2016). Students are encouraged to process at a deep level, with reflection that might be signified through practical applications of theory.

Kang and Chang (2016) believe that social hierarchy and harmony are valued in the Confucian approach while personal freedom and individuality are valued in the Socratic approach. Therefore, instructors can help students from Confucian cultures study in Western E-learning environments by providing "collaborative team projects and eliminating competition" (Kang and Chang 2016, p. 790).

Furthermore, Kang and Chang (2016) explain that American students value freedom and individualism. For student learning behaviors this is like the idiom "you can lead a horse to water, but you can't make it drink." My personal learning and teaching experiences in the U.S. higher education have shown that if an American student fails to attend lectures, finish his or her assignments, or complete required readings, most instructors do not micro-manage the student; it is the student's individual responsibility. However, the teacher's cultural identity also plays a part in how the e-learning environment is set up.

Spizzica (1997) describes the teaching and learning cultural differences within "Western" and "Eastern" education. For Eastern education, "teacher-centered education, students need to accept teacher's opinions without giving own critique and memorization is a key tool in learning (p. 9)" and for Western education, "student-centered education, critical analysis is a key tool in learning" (p. 9). Chinese and American learning styles are examples of the broader contrast between Eastern and Western education. Western students' learning strategies starts with exploration while Chinese children learn through concrete examples (Wong 2004). Wang and Wang (2012), Brazill (2016a, b) assert that Chinese students tend to think circularly, while English speakers tend to think linearly (see Fig. 1).

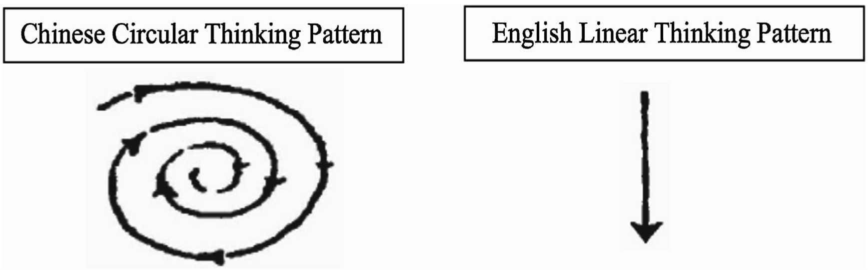

Fig. 1. Different thinking patterns (Source: "Causes of and Remedies for Chinglish in Chinese College Students' Writings," by P. Wang, and W. Wang, 2012, June 12, Open Journal of Modern Linguistics, 2(02), p. 71. Copyright 2012 by SciRes.)

Clifford (2008) describes a scenario in which an Asian student studying in the West shared his point of view about classroom discussions. The student explained that in classes with professors, he never talked or asked any questions. He would wait for other students to ask questions for him. The other Western students would argue with professors, which made him uncomfortable.

This perspective from an Asian student explains much about why Chinese students do not challenge or question their teachers and peers. Chinese students are often perceived as harmonious, cooperative, and respectful (Hwang 1987). Kumaravadivelu (2003) elucidates a common stereotype about Chinese students, that they trust and obey authority – their teachers, readings, and other sources of knowledge conversations. This stereotype is evident as explained by cultural identity theory as the value, beliefs, thinking patterns, and behaviors that are shared and that characterizes as a group of people.

Chinese students must memorize material for the examination system in China, but they may not fully understand the concepts or be able to put them into practice; this is an example of rote learning (Kember 2000). Sit (2013) observes that some researchers think Chinese students fall into the category of "silent learning", which can be traced to Confucian cultural influences that require students to respect hierarchical relationships. Chinese students are taught not to interrupt their teachers during class. Most Chinese students and teachers believe that wasting other students' class time by expressing independent opinions and concerns are considered inappropriate and selfish behavior, which also might cause teachers to "lose face" (Hu 1944; Ho 1976). Thus, Americans have the misconception that Chinese students do not ask questions (Kennedy 2002). The underlying misconception and generalization that Americans hold about Chinese students is that they are passive learners (Kember 2000).

However, this misconception is not quite true. Zeng (2006) claims that Chinese college students not only actively learn from their professors, but also interact with their professors after class to clarify any confusion in their learning material. These non-classroom interactions have a positive effect on their career aspirations. Some Chinese students write down their questions during class and wait until after class to talk with their teachers. Chinese teachers are helpful, encouraging, and think highly of those students who ask questions after class. As Pratt et al. (1999) point out, the harmonious interactions between Chinese teachers and students are not limited to a short-term relationship and academic learning but are part of the life-long positive influence that Chinese teachers have on their students as role models. In contrast, American students are encouraged to be critical and challenge their teachers in the classroom (Ladson-Billings 1995). The effects of being critical and challenging teachers is evidence that American students are self-directed learners and they construct knowledge by challenging their teachers (Kang and Chang 2016, p. 790).

Chinese students process and construct knowledge differently than American students through inquiry with their instructors. Cheng (2000) describes a well-known Chinese motto, *Qin Xue Hao Wen*, which means a good student should be diligent and always be ready to ask questions ("Xue" refers to "learn" and "wen" means "inquiry"). It stresses the importance of inquiry, so Chinese students do employ a deeper approach to learning that goes beyond memorization. Tu (2001) suggests that Chinese learners require clear instructions in an E-learning classroom discussion due to their cultural Identity in contrast to the open discussions that American students take for granted. According to a study by Yuan (2011), American students are expected to speak up in classroom discussions because being quiet is considered a marker for incompetence, lack of confidence, and unpreparedness. Furthermore, American students are taught to apply knowledge to hands-on projects. Therefore, it appears that cultural differences impact students' E-learning behaviors.

3 E-Learning

E-learning uses digital material on the Internet and computer-mediated instructional (CMI) systems as an environment for the exchange of information and interaction between learners and instructors (Bermejo 2005). CMI is teaching using computers as tools to exchange texts, images, audios, and videos (Fitzgerald et al. 2008). E-learning is a kind of CMI, which can be synchronous, asynchronous, or real-time interaction through learning management systems (Colace et al. 2003).

E-learning (synonyms of terms for E-learning are distance, online, hybrid, and blended learning/flipped classroom) is both a form and the process that occurs when consuming and interacting with CMI and new media. In contrast to traditional media (newspapers, magazines, books, television and other non-interactive media), new media is broadly defined as various kinds of digital communications (websites, online videos/audios/social platforms/communities, blogs, and other media that allow interactivity) that are possibly due to innovation in computer technology (Liu et al. 2009).

4 Instructional Design for E-Learning

Instructional design methods are fundamental for enhancing E-learning experience. Swan (2002) argues that various methods can be used to significantly improve E-learning outcomes. These methods are clarity and consistency in course design, promoting feedback, active discussions, and interaction with course content, instructors, as well as peers. Hence the need for blogs, chat groups, and other forms of group and individual instructional interactions and contacts. Bowen (2017) emphasizes the backward design approach in E-learning, which begins with course outcomes and objectives, then assessment evidence, and then the planning. These three stages in the backward design model are classified as: identify desired results, determine acceptable assessment, and plan learning experiences and instruction to achieve the desired results. Granic and Cukusic (2007) identify Universal Design within the context of E-Learning environment prompting individualization, ensuring usability, accessibility, and inclusive to diverse learners.

Keller's (1987) ARCS model of motivation is an instructional design model and theory that applies to both face-to-face and E-learning environments. The ARCS Model stands for attention (A), relevance (R), confidence (C), and satisfaction (S). It's a seminal model and it is the basis of many current studies. First and foremost, E-learning material must be interesting and able to keep students' attention. Second, E-learning material must be relatable to students' experiences and future career needs. Third, E-learning material must have clear objectives and build students' confidence. Fourth, E-learning material must have a reward process such as positive comments or feedback from instructors. Research indicates that Keller' ARCS model of motivation positively affects students' learning outcomes. Furthermore, Marzano and Pickering (2010) provide insightful strategies (for example, using effective pacing, demonstrating intensity and enthusiasm, building positive teacher-student, and peer relationships connecting to students' lives, etc.) that engage students in the short-term and long-term which can apply in E-learning classrooms.

According to Garrison et al. (1999), the Inquiry-based Learning Model offers us specific guidelines when it comes to designing web-based courses. Like the ARCS model, it is a best practice for both face-to-face and E-learning. As shown in Fig. 2, the model emphasizes social presence, teaching presence, and cognitive presence. Social presence is defined as to project personal characteristics into the classroom by presenting to others as "real people." Teaching presence includes the design, presentation, assessment, facilitation of the teaching material, engagement and relationships with the students. Cognitive presence is especially important for web-based course design and is defined by the ability of students to construct meanings behind texts and to apply critical thinking skills in online courses.

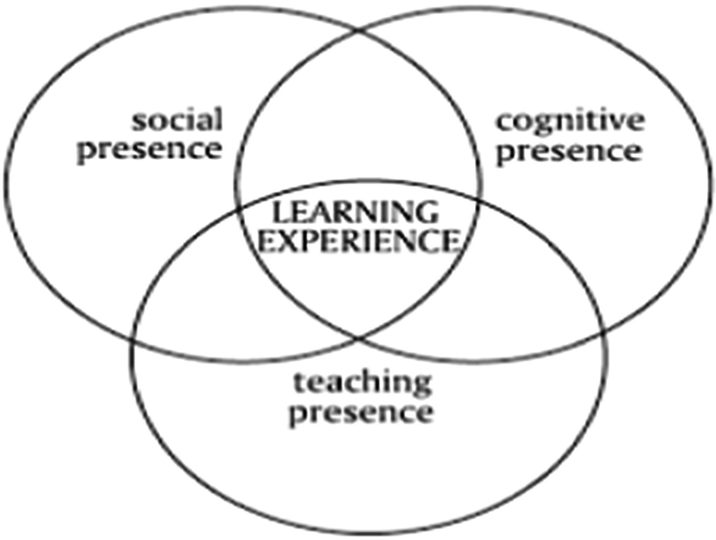

Fig. 2. Community of inquiry model (Source: "Critical inquiry in a text-based environment: Computer conferencing in higher education model.," by D. Garrison, W. Archer, & R. Anderson, 1999, Spring, *The Internet and Higher Education*, *2(2–3),* p. 88. Copyright 2000 by Elsevier Science Inc.)

Furthermore, The Inquiry-based Learning Model can be adapted to E-learning. It encourages students to ask good questions, and students and faculty to have frequent interactions. For example, online instructors can establish teaching presence by putting a face on video lectures with interactive quizzes rather than giving students separate and purely text-based materials. An inquiry-based learning framework could be used in E-learning in the following ways: setting clear expectations, making frequent course announcements, providing social forums, posting lectures, hosting teacher-led discussions, and encouraging student-led discussions.

Additionally, Bloom's (1965) taxonomy of learning framework is a cognitive structural approach that works well in combination with the community of the inquiry model. Figure 3 shows how Bloom's taxonomy of learning clearly defines learning objectives as a cognitive process that unfolds in discrete stages. This review will draw on Bloom's theory and define the levels of differences between Chinese and American students' E-learning behaviors.

Fig. 3. Bloom's taxonomy of learning (Source: "Using Bloom's Taxonomy to Write Effective Learning Objectives.," by J. Shabatu 2018, May 19, *Tips University of Arkansas*, Retrieved March 11, 2019 from https://tips.uark.edu/using-blooms-taxonomy/. Copyright 2018 by University of Arkansas.)

Although many of these models were developed for face-to-face learning, the special features of E-learning make it suitable for the adaptation of these models. In order to maximize E-learning, instructional design should be culturally sensitive to students in the class. When focused on students from diverse cultures, E-learning is also an example of the global flow of information and culture (Ismail 2001). Wang (2006) suggests culturally sensitive strategies for teaching students from different cultures by facilitating social communications among students through activities and encourage students to share their biographies, family stories, or other personal experience.

5 Cultural Theory for E-Learning

It is imperative for this study that we understand cultural theory for E-learning design. Cultural diversity in E-learning is an increasingly popular topic because the US has become known as a melting pot and salad bowl with many incoming international students (many from China) from diverse cultures who lack E-learning experience and skills. Chinese and American students learn quite differently, and because these two nations are educational leaders it is especially important that we understand E-learning in an intercultural context and develop intercultural communication competency, which is the ability for one to communicate effectively and appropriately with people of other cultures.

Keller's ARCS model of motivation (1987) described above is intended to apply to all cultures but does not explicitly incorporate cultural dimensions and values. To remedy this gap, Hofstede's Cultural Dimensions Theory (1984) can be applied to design courses for students from a variety of different cultures. It is a framework focusing on observable or measurable criteria such as:

- Power distance;
- Collectivism vs. Individualism;
- Femininity vs. Masculinity;
- Uncertainty vs. Avoidance;
- Long/short term orientation; and
- Indulgence vs. Restraint.

Over the years, many researchers have documented profound differences between Chinese (Eastern) and American (Western) culture. Hofstede's study of Cultural Dimensions has emerged as a popular and widely cited work that provides insights into the two cultural dimensions in ways that give course developers and teachers insights into E-learning behaviors and other practical aspects of communication.

China and the United States are very different in terms of language. This is true, but more importantly the two populations are profoundly different in cultural, social, and other ways that shape communication patterns and E-learning education practices. There is also a great difference in the two cultures' "Long Term Orientation" scores. Hofstede's (1984) describes Americans as conservative, they believe the truth of American culture never changes, there are absolute moral values defining good and evil, and they look for quick results. Chinese, on the other hand, are very pragmatic and quickly adapt to changing times, and are willing to set long-term goals and endure a lot of pain (or "eat bitter"; chi ku) to reach them. This helps explain "Chinese Anxiety regarding Modernism" (Xie 2008)", wherein "Modern" is equated with "Western". Thus, many Chinese young people desire to adopt Western values by living more in the moment and being more individualistic, especially while living in the US. Figure 4 shows Hofstede Cultural Dimensions for China and the U.S. Americans are very individualistic whereas Chinese are very collectivist—i.e. Chinese people tend to define identity through group membership (Yeh and Huang 1996; Ardichvili et al. 2006).

Likewise, Hall's (1976) cultural classification of high-context vs. low-context provides a cultural theoretical framework for E-learning. Hall's theory explains how culture drives learning behavior and thus requires personal instruction techniques. High-context cultures communicate in ways that are implicit and rely heavily on context. In contrast, low-context cultures rely on explicit verbal communication. America is known as a "low-context" culture, whereas Chinese culture is known as "high-context" and Chinese language is full of ambiguity. In high-context cultures, an understanding of unspoken rules of engagement and indirect implicit communication is required. In low-context cultures (e.g. Western cultures), a direct and explicit approach is the key for effective communication between independent individuals. This is

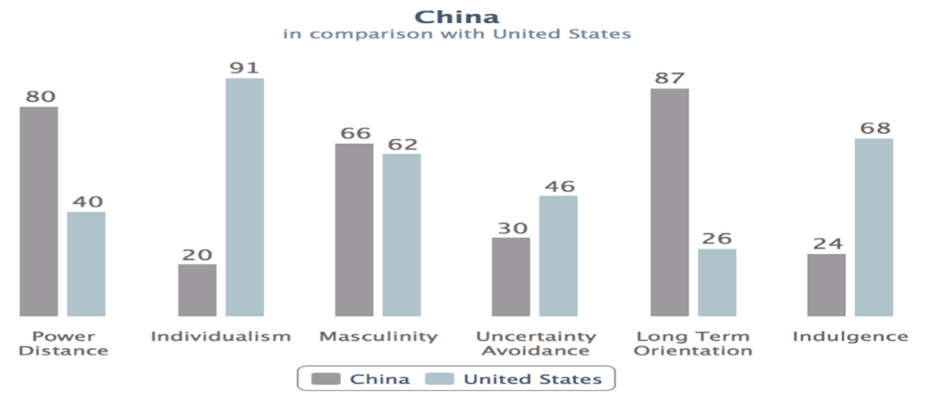

Fig. 4. Hofstede cultural dimensions (Source: "Hofstede Insights," by G. Hofstede 2018, *Country Comparison What about China*, Retrieved December 11, 2018 from https://www.hofstede-insights.com/country-comparison/china,the-usa/. Copyright 2018 by Hofstede Insights.)

especially important for E-learning instructional design and assignments. According to Tu (2001), students from low-context cultures will likely be fully engaged in discussion boards or essay questions because the low use of nonverbal elements, and that meanings are carried more by words than by nonverbal means. However, for students from high-context cultures to share their perspectives, assignments should include audio or visual content or be given through a social media platform because Chinese students rely more heavily than Western students on verbal and non-verbal cues from the instructors to share ideas.

6 Conclusion

While researchers (Li 1998; Brazill 2016a, b; Rapaille 2007; Culture Code 2011; Yu 2013; Brazill 2019) have examined the differences between Chinese and American cultures, few studies have explored potential differences among Chinese and American students enrolled in E-Learning education. E-learning has become increasingly common for American university students, but little thought has been given to the role of cultural dimensions. It is vital to meet the needs of diverse students and to maximize learning outcomes in E-learning. The review paper addresses this knowledge-gap on how culture shapes E-learning behavior in online undergraduate education. It will provide guidance to universities and instructors on becoming more culturally sensitive to students' learning behavior. It will allow us to test many assumptions about intercultural communication, E-learning, computer-mediated communication and cultural identity theory. And, finally, it would improve students' learning outcomes in the online learning environment.

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Developing Critical Cultural Confidence Through Media-Assisted Problem-Based Learning in the Chinese Culture Class

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Abstract. In the face of the modern age of new information and technologies, new competence and qualities tackling real-life problems for innovation are of necessity. This study proposes the concept of critical cultural confidence based on the critical thinking threshold concept. It is subject to gradual improvement towards the state of affirmation of self culture in relation to the wider world. Thirty-four Chinese undergraduate students majoring in English language and taking the course of Chinese culture used the media-assisted problem-based learning (PBL) with access to different media in three learning cycles for real-life problem-solving. In this media-assisted PBL classroom, media literacy served as the core supported by the appropriate use of technology for learning. With the use of questionnaires and interviews along with results of students' academic performance, it was found that adequate curricular design and continuous dynamic collaboration in the nurturing environment contributed to their epistemological and ontological development of critical cultural confidence. Implications for the implementation of media-assisted PBL under the inherent Chinese cultural characteristics are then provided.

Keywords: Critical cultural confidence · Critical thinking · Threshold concepts · Media-assisted problem-based learning

1 Introduction

Problem-based learning (PBL) has been argued as a curriculum and pedagogy for learners prepared for the uncertain future [1]. What traits or qualities are required for the future with new information and technologies has also been discussed. Those in the list are usually problem-solving and teamwork skills, creative and critical thinking. Media-assisted PBL used in the Chinese culture class focused on in this study was specifically aimed to help students develop critical cultural confidence based on critical thinking threshold confidence meaning feeling comfortable after achieving new knowing developed through the process of reasoning. It is argued that in the new era, new thinking and capabilities are vital to the sustainability of Chinese culture which has a long history. Critical cultural confidence thus requires conceptual understanding and practical abilities to convert the feeling to action, leading to epistemological and ontological transformation. Through PBL resonating with threshold concepts as

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"a pedagogy of uncertainty" put forward by Land [2], thirty-four Chinese students studying in the class of Chinese culture participated in self-directed and collaborative learning. Their epistemological and ontological development of critical cultural confidence was explored.

This paper starts by defining critical cultural confidence and building the framework thereof to investigate how the student participants changed in the PBL process. Learning with technology [3] serves as the propeller for critical cultural confidence, while media literacy to critically read and write the media is taken as the core. Students' assessment results in three learning cycles of accessing various media, pre-class and post-class questionnaires and semi-structured interviews were employed for analysis. Implications for PBL implementation in the development of critical cultural confidence in the epoch of modern technology are then provided.

2 Literature Review

Critical cultural confidence is grounded on critical thinking referring to the gradations of knowing, being, and practical capabilities. In response to the media-assisted PBL process, it is demonstrated as making good use of the media to understand self culture, connecting self to the wider cultural context, and taking action to solve real-life problems. Conceptual and practical dimensions are thus included. Situating critical cultural confidence in threshold concepts might be of help to grasp the learning journey, for threshold concepts are in nature transformative and troublesome and defined as "akin to a portal" [4] and "conceptual gateways" [5].

2.1 Defining Critical Cultural Confidence

Confidence is often attached to affirmation and assurance. In learning settings, linked to culture, confidence can be regarded as the state of certainty or assertiveness in self culture bound in different dimensions of a society. Yang [6] argues cultural self-confidence as "the full affirmation to the cultural deposits and the cultural value and the foundation of national culture to maintain vitality". This study stresses that in order to maintain vitality, certainty or assertiveness in self culture needs to be supported by critical thinking as a threshold concept [7] because cultural confidence is not confined to a fixed status but a transforming renewal in connection to the broader environment. The learning journey of critical thinking as departing from inquiry and continuing through reflection [8–10] echoes variations in threshold concepts from a naïve state to sophistication. Generic values of the critical thinking threshold concept such as argument, analysis and judgment-making, in this sense, cannot be disentangled from development in learning. Felton [11] considers threshold confidence based on threshold concepts as feeling comfortable after mastering in a new knowing territory and connects it to "sense of belonging" in a particular group. Crossing the threshold brings about self repositioning and increasing confidence in the emerging identity [12], and innovation and adaptation give rise to conceptual and ontological shifts [13]. According to critical thinking threshold confidence, critical cultural confidence is defined as gradual improvement towards the state of affirmation of self culture with sophisticated wider epistemological understanding, ontological transformation, and practical capabilities to acquire mastery. It is therefore competence as well as qualities exemplified in stages from simple knowing, intergrading knowing, evaluative knowing, to integrative knowing contributing to enhancement of self culture.

2.2 The Epistemological and Ontological Framework in PBL

Provided that critical cultural confidence is required in the modern society with new technologies, it takes on heightened importance to put it into practice in PBL. With the elastic nature, PBL tends to be able to be applied across disciplines due to threshold experiences of cognitive and ontological change [14]. Kek and Huijser [15] point out heterogeneity of the next generation of learners and the capacity of PBL for identifying and developing the prior skills for the digital generation. Given that the media-assisted PBL was used to develop critical cultural confidence, this study built the epistemological and ontological framework drawing on four phases of variation in reaching threshold concepts from sub-liminal, pre-liminal, liminal, to post-liminal referring to shifts in understanding and mastering knowledge [16]. The stages are presented with students' quantifiable assessment criteria as in Table 1.

Table 1. The epistemological and ontological developmental framework in PBL

Critical cultural confidence stages	Epistemological development	Ontological development
Stage 1-Integrative knowing (post-liminal) (Marks 90–100)	Integrating cultural knowledge and developing updating ideas	Self being stretching out for possibilities
Stage 2-evaluative knowing (liminal) (Marks 80–89)	Synthesizing and evaluating cultural knowledge	Self being formed and understood
Stage 3-Intergrading knowing (pre-liminal) (Marks 70–79)	Acknowledging cultural knowledge as uncertain against the wider context	Self being interacted with wider values
Stage 4-Simple knowing (sub-liminal) (Marks 60–69)	Accepting cultural knowledge without considering the background	Being determined by external values

Critical cultural confidence in the sophisticated phases of stages 1 and 2 is likely to bring about practical innovation. Students in the stages have the potential to propose new ideas to solve problems or deal with current issues with the use of knowledge or skills breaking disciplinary boundaries. The improvement requires PBL as a pedagogical vehicle prompting collaboration between peers, as well as that between the teacher and students.

2.3 The Media-Assisted PBL Teaching-Learning Model

To implement the framework in media-assisted PBL, adequate design of ill-structured problems is the starting point. Problem scenarios in response to the real-life issues are offered, along with the teacher's facilitation, peers' collaboration and assessment. Yu, Lin, Ho, and Wang [17] stress that how the technological medium is used with PBL affects student's academic achievement and critical thinking and imply that blended-learning environments with technology may provide flexibility to overcome time limitations. In this classroom practice with media-assisted PBL, media literacy of critically approaching media messages is placed at the center and surrounded by the use of technology to assist learning in a semester of 16 weeks. For this purpose, knowing-reflecting-stretching [18] stemming from inquiry and continuing through reflection was proposed as the two-way PBL teaching-learning model in the Chinese culture class. In the media-assisted PBL class, students are encouraged not merely to use a variety of media but to "make good use of" the media to collect, analyze, evaluate and integrate information to devise new ideas for real-life problem-solving and innovation. Figure 1 shows how the model might work.

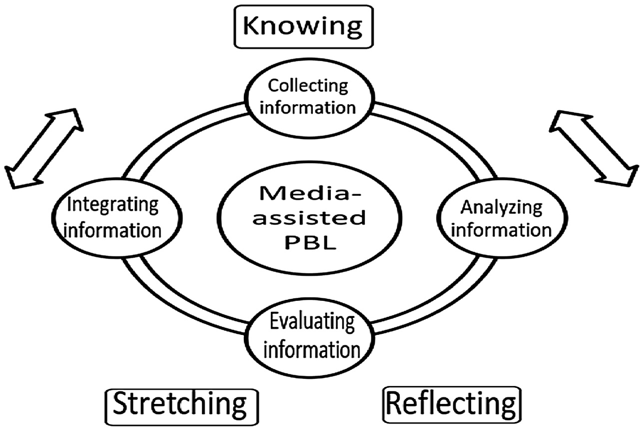

Fig. 1. The media-assisted PBL teaching-learning model

3 Methodology

The study maintains that learning Chinese culture should not be restricted to knowledge from the textbook but lies in referring to more cross-disciplinary information. Student participants were encouraged to use information and technologies to assist teaching and learning in a range of fields. In the classroom equipped with a podium with multimedia information facilities, students used their smart phones as technological tools to follow the PBL procedure for identifying the research problem, searching for the factual information, and analyzing and evaluating. For teacher-student communication after class, the teacher and all the students were added as members in the class QQ group.

The media-assisted PBL employed in the Chinese culture class involved three learning cycles with three themes: cultural renovation, technological innovation, and city sustainability under which corresponding problem scenarios were provided for students to decide specific problems and issues to study. In the first classes of the course and each of the three cycles, original mini-lecture videos made and edited by the teacher were shown to elicit discussion on the existence of some real-life issues or problems and the possible ways of tackling them. Thirty-four students majoring in English language were divided into seven groups with five members and worked together in the 16-week class. Each cycle lasted for five weeks, and the fifth week of each cycle was the formative assessment. Students used a variety of ways to present their ideas of innovation and creativity, including the Powerpoint presentation for the first theme, advertisement for the second theme, and self-edited videos for the third theme. The final summative assessment was held in the 17th week to evaluate how individual students perceived their learning in the process and understood Chinese culture. Students' assessment results, pre-class and post-class questionnaires of their perceptions of Chinese culture and learning of Chinese culture and their semi-structured interviews were analyzed to validate the findings.

3.1 Students' Assessment Results

In each cycle, the teacher assisted the students in identifying the specific problem for study by following the procedure for problem identification. On the basis of their interests, seven groups of students attempted to identify the research problem, establish learning objectives, collect factual information from the media and propose learning questions. In the process, it was recognized that students tended to start their mobile learning from two categories of familiarity: familiarity with the topics relevant to their life experiences and familiarity with the web sources such as Baidu for searching and Tencent for films and videos. The familiarity was reflected in their choices of topics for studying presented as in Table 2, together with the results of their group average formative assessment marks with thematic codes, individual summative assessment marks, and the correlation between the formative and summative academic results.

The seven groups of students had access to media of their choice to collect information for investigation and demonstrated their levels of critical cultural confidence at the end of each of the three cycles. It was found that the most students reached the stage of evaluative knowing with 11 times in formative assessment. Those reaching the stage mainly demonstrated critical cultural confidence in two categories with thematic analysis: deep reflection on real-life problems (R) and wide consideration to different perspectives (C). As the frequency in Table 2 shows, eight out of 11 are concentrated on reflection on life, indicating critical cultural confidence is built on awareness of self culture and adequate modification against the wider cultural context. For example, group one promoting Hanfu, the traditional Chinese costume, developed their ideas of integrating fashionable elements into the design of new Hanfu. One group member observed the difficulties in promoting tradition while filming for presentation,

> When we walked in the campus, everyone looked at us as if it was odd. It was because few people wore Hanfu in the campus, and they were curious about why we did so. According to our video interview, Chinese people are shy of expressing their praise and appreciation directly although they think Hanfu is beautiful.

Table 2. Students' choices of topics and assessment results

Groups/Marks	Themes				
	Cycle one: cultural renovation	Cycle two: technological innovation		Cycle three: city sustainability	
Group one	The promotion of Hanfu (80) (R)	Dish washing machine (70)		Shanghai, Pearl of China (69)	
Group two	How and why foreigners celebrate Chinese traditional festivals (88) (C)	Trans—AI interpreter (85) (R)		Beihai's external population (85) (R)	
Group three	Different types of tourist attractions and environmental sustainability (75)	Interior decoration hologram (88) (C)		The development of the ancient city Pingyao (75)	
Group four	The conflict between Huaiyang cuisine and modern cuisine (76)	Soft-Screen Phone (75)		The liveable city-Suzhou (85) (R)	
Group five	The contradiction between traditional festivals and the environment (76)	The trash can of Intelligent classification (84) (C)		Traditional culture vs. tourism development in Luoyang (75)	
Group six	Yangzhou Tea (80) (R)	The beauty robot (83) (R)		The development of Huai'an (80) (R)	
Group seven	Double Seventh Festival (70)	New Energy vehicles (76)		Weihai's tourism resources (82) (R)	
Numbers of individual final marks (n = 34)	Stage 1 (Marks 90–100)	Stage 2 (Marks 80–89)	Stage 3 (Marks 70–79)	Stage 4 (Marks 60–69)	Stage 5 (Under the marks 60)
	0	7	13	6	8
Correlations n = 34	Cultural renovation assessment	Technological innovation assessment		City sustainability assessment	
Pearson Correlation	.140	.225		.239	
Individual final marks Pearson Correlation Sig. (2-tailed)	.429	.200		.173	

P > 0.05 no significant correlation found

She linked the difficulties to Chinese characteristics and the context though they proposed a possible solution. Another member in group two, as an English language major, reflected on the development of electronic translator in the Chinese environment,

> With the application of deep learning and other technologies in artificial intelligence, the AI translation market has great potential. However, there are also problems of translation machinery, such as bluntness and poor overall matching. We must enhance our professional knowledge so that we can have an edge over the competition with the machines.

He pointed out the weakness of AI translators in recognizing emotions and tones and urged for the humanized AI translator, which needs professional knowledge in disciplines of computing and science. In the third cycle of city sustainability requiring broader cross-disciplinary knowledge, students referred to online information on the cities of their interests and edited the videos of their version. Four out of seven groups reached the evaluative stage because of deep reflection on the city issues and providing possible solutions. Due to lack of technical filming skills and long distance to those chosen cities, however, only group six produced their video of originality.

In contrast to the first category of reflection on problem-solving stemming from real-life experiences, the second category of wider consideration revolved around access to media of different perspectives rather than focusing on those rooted in China. Take the topic of foreigners' celebration of Chinese festivals chosen by group two for example, the group members endeavored to present the similarities and differences between foreign ways and Chinese ways of celebration, intending to provide observations from other angles. One student concluded,

> It is quite necessary for foreign countries to celebrate Chinese festivals because it shows the internalization of Chinese traditional culture. What's more, we must focus on spreading not only its traditional culture, but also its modern culture as it is a new form of Chinese culture developed from tradition.

Through referring to various web resources, they believed in the importance of glorifying Chinese culture on the global stage. They demonstrated their abilities to synthesize and evaluate diverse cultural knowledge. Their knowing, nonetheless, was limited to offering further constructive suggestions requiring more sophisticated understanding of the world context.

Distinct from the results of formative assessment in the process, those in the final summative assessment showed that the most students (13 students) stayed in the stage of intergrading knowing, indicating that their recognition of critical cultural confidence was initiated. Students generally revealed their confidence in self culture but insufficiently reflected on the PBL journey and how the chosen media assisted them in strengthening their critical cultural confidence. No statistically significant correlation found between the academic results of group work and those of the individual assessment manifested students' diverse tortuous learning curves. It might be claimed that in the media-assisted PBL process, continuous group work with reflection, wider access to various media, and the teacher's facilitation helped students constantly modify their ideas for better new meaning construction.

3.2 Pre-class and Post-class Questionnaires

Apart from students' assessment marks demonstrating their levels of critical cultural confidence according to the epistemological and ontological framework, students completed the pre-class questionnaires at the beginning of the course and post-class questionnaires after the end of the course. The results are presented as in Table 3.

Table 3. Results of the pre-class and post-class questionnaires

Pre n = 34 Post n = 30					
No./The paired samples t-test Sig. (2-tailed)	Agree strongly5	Agree slightly4	No opinion3	Disagree slightly2	Disagree strongly1
1. Chinese culture has its characteristic value superior to others' because of the long history. *p = 1.000*	Pre 11/32%	Pre 12/35%	Pre 2/6%	Pre 5/15%	Pre 4/12%
	Post 12/40%	Post 12/40%	Post 1/3%	Post 3/10%	Post 2/7%
2. Chinese culture can be dominant because of a lot of population. *p = .326*	Pre 0	Pre 12/35%	Pre 5/15%	Pre 11/32%	Pre 6/18%
	Post 3/10%	Post 7/23%	Post 5/17%	Post 11/37%	Post 4/13%
3. It is difficult to generalize the content of Chinese culture because of different local regions in China. *p = .023*	Pre 16/47%	Pre 9/26%	Pre 3/9%	Pre 2/6%	Pre 4/12%
	Post 14/47%	Post 9/30%	Post 5/17%	Post 1/3%	Post 1/3%
4. It is useful to learn about Chinese culture in the world of mobility. *p = .005*	Pre 21/62%	Pre 11/32%	Pre 2/6%	Pre 0	Pre 0
	Post 19/63%	Post 5/17%	Post 5/17%	Post 1/3%	Post 0
5. It is interesting to learn about Chinese culture in the face of the fast-changing world. *p = .264*	Pre 13/38%	Pre 15/44%	Pre 5/15%	Pre 1/3%	Pre 0
	Post 15/50%	Post 10/33%	Post 3/10%	Post 2/7%	Post 0
6. I would love to explore more about Chinese culture in relation to the real world. *p = .662*	Pre 15/44%	Pre 13/38%	Pre 6/18%	Pre 0	Pre 0
	Post 18/60%	Post 8/27%	Post 4/13%	Post 0	Post 0
7. Learning about Chinese culture through the text book is enough. *p = .012*	Pre 1/3%	Pre 2/6%	Pre 2/6%	Pre 13/38%	Pre 16/47%
	Post 0	Post 1/3%	Post 2/7%	Post 14/47%	Post 13/43%
8. Starting from a problem can be effective in learning more about Chinese culture. *p = .326*	Pre 11/32%	Pre 13/38%	Pre 8/24%	Pre 1/3%	Pre 1/3%
	Post 8/27%	Post 17/57%	Post 5/17%	Post 0	Post 0

Comparatively, students generally perceived Chinese culture as precious given its long history, with 23 and 24 students choosing *Agree strongly* and *Agree slightly* responding to statement one in the pre-class questionnaire and post-class questionaire respectively. In response to statement three, most students (25 and 23 students) recognized the diverse content of Chinese culture. With reference to learning, according to choices to statements four, five and six, students showed interest in studying Chinese culture in general. Most of them also agreed that investigating a problem might be effective in learning Chinese culture, with 24 and 25 students choosing *Agree* in the pre-class questionnaire and post-class questionnaire respectively. According to the paired samples t-test statistics, the means of students‘ responses to statements 3, 4, and 7 before the class are statistically significantly different from those after the class, suggesting students‘ changing perceptions after the implementation of the media-assisted PBL.

3.3 Semi-structured Interviews

Students' perceptions of Chinese culture were also obtained in the semi-structured interviews. At the beginning of the course, students were asked general questions about what they thought of Chinese culture and what they expected to learn. Not surprisingly, all of the 34 students talked about traditional customs and values such as Chinese festivals, Martial Arts (Kung Fu), four great inventions and Confucianism affecting other parts of the world. Regarding their expectation of learning in the class, one student articulated,

> I hope I can strengthen my cultural quality on the basis of raising awareness and have a preliminary understanding of the specific knowledge of each sub-discipline of Chinese culture, and use this knowledge to observe society and understand society.

Growing up and living in a country of long history, those Chinese student participants tended to be inherently reliant on self culture. With access to different media and online resources, they found it useful to expand their cultural knowledge. In addition to exploring different aspects of Chinese culture and enhancing professional knowledge in English, some students also expressed their willingness to connect their knowledge to the wider society before formally starting their PBL study.

At the end of the course, in contrast, students were still generally confident of Chinese culture as their root but also acknowledged the challenges of promoting Chinese culture. A student, for example, talked about the influence of westernization,

> Nowadays, with the promotion of globalization, many young people's thoughts are deeply influenced by the western culture. Some people do not celebrate our traditional festivals and choose to celebrate the Christmas or Halloween.

In response to the current events of the conflict between China and the United States, another student mentioned the controversy over Hua Wei's 5G and shutting down the Confucius Institute in some foreign higher education institutions. For encouragement, he thus attempted to promote the possibilities of innovating technologies and their group product of AI interpreter in the second cycle. He further talked about the condition of his critical cultural confidence by "thinking alone and working together", reflecting his status as an individual member working with peers in a team. He pointed out the importance and difficulty in teamwork, the subtlety of collaboration between individuals and other group members in the Chinese learning context.

3.4 Discussion

As the results from students' assessment, pre-class and post-class questionnaires and semi-structured interviews proved, the development of students' critical cultural confidence in the media-assisted PBL process consisted in:

(1) Self-awareness of the importance of self culture.
(2) Wide access to the media presenting different perspectives.
(3) Frequent updating new ideas after justification.
(4) Cross-disciplinary knowledge and skills.
(5) Constructive teamwork.
(6) The teacher's regular facilitation.

In particular, it might not be legitimate to assert that teamwork can definitely contribute to critical cultural confidence development, while contested ideas emerging in the media-assisted PBL challenged students' capabilities of organizing group members' thinking and managing a diversity of online information and materials. The findings also implied the necessity of developing students of good cultural quality who are open-minded to read various pieces of information and write their constructive ideas based on justifiable evidence.

It has been claimed in this present paper that reflection gives an impetus to stretching towards higher-level confidence. With the use of mobile phones as searching tools in the classroom, it was found that students' reflection required stimulation from discussions with both group members and the teacher. The function of the QQ group after class, however, was inclined to serve as a platform for the teacher to allocate tasks and for the students to take assignments rather than providing dynamic interaction. Students seemed to prefer to have discussions with their group members in private, either in person or online. This made the implementation of PBL difficult in the constructivist environment where the teacher's role shifts from a didactic instructor to a facilitator [19]. In contrast to the presumed open PBL environment, the actual implementation tended to be conservative. To develop critical cultural confidence in which critical thinking is embedded, though Du, Emmersen, Toft, and Sun [20] found PBL conductive to a higher disposition of critical thinking of Chinese students, in the Chinese educational settings, curricular adjustability and ongoing exposure to the active learning environment should be attached more attention. The transformation of the teacher's role and students' role, then, requires the aforementioned conditions under the wider nurturing circumstances.

4 Conclusion

This paper has developed the concept of critical cultural confidence based on the critical thinking threshold concept and examined 34 undergraduate student participants' epistemological and ontological development. Using a variety of media as the base of gathering information in the classroom, students constructed their new meanings by proposing new ideas for cultural renovation, making the advertisement for their technological products and editing videos showing how to approach city sustainability.

From the results of their formative and summative assessments, students tended to be concentrated in the intergrading stage and the evaluative stage, demonstrating their potential for higher-level critical cultural confidence. In the Chinese cultural context, however, Dong [21] argues that the uncritical Chinese characteristic in cognition and the emphasis on materialism in the Chinese society may hinder students from developing critical thinking leading to innovation. According to this study, students started to develop their understanding of self culture connecting to the wider world and situate their beings in the larger environment. Their ongoing exploration accessing more media representing different perspectives might be of help for broadening their views in knowledge, and learning skills of different disciplines can contribute to practical problem-solving. Critical media access in PBL paves the way for possible future genuine cultural contact, invigorating critical cultural confidence. The requirement of cross-disciplinary knowledge and skills also denotes that innovative learning for the future should not be cooped up in a particular area. Understanding how to approach necessary knowledge and competence with good personal quality is hence of significance.

Media literacy as the core in media-assisted PBL needs to be supported by the appropriate use of technology. In classroom teaching, the teacher acted as a facilitator guiding and eliciting students' ideas which might be widened and deepened through researching online. The teacher-student interactive QQ group used after class, in contrast, was not sufficiently functionalized. It might suggest that face-to-face facilitation plays a significant role in pushing students to express their opinions in the Chinese learning environment. Though this study was limited in the size of the participants and time of the implementation, it tended to be discernible that with appropriate curricular design and facilitation in media-assisted PBL, groups of students were able to show their "possibilities for the future". Further research can be conducted to investigate the ways of enhancing the use of technology such as social media outside of the classrooms in different cultural contexts and how it can impact the development of students' critical cultural confidence epistemologically and ontologically. For the educational purpose of this study, making good use of the media and technology in PBL with the teacher's and students' dynamic participation can further strengthen the base for the developmental process. It might be imaginative to propose new ideas and invent technological gadgets in the classroom; future innovation, nonetheless, cannot be made possible if there is no bravery in breaking through.

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