The International Workshop on Technology-Enhanced Collaborative Learning (TECL 2016)
In conjunction with CRIWG/CollabTech 2016

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Preface

The aim of this work is to provide a forum where international participants can share knowledge on the latest developments in technology-enhanced collaborative learning environments as well as map out directions for future developments and research collaborations. In this 2016, a total of 22 papers from five countries are accepted for presentation in TECL 2016. The topics of the papers presented in this workshop include emerging tools and technologies for collaborative learning, learning strategies for technology-enhanced collaborative learning, assessment strategies for technology-enhanced collaborative learning, development of digital content for collaborative learning, and domain-specific applications of technology-enhanced collaborative learning.

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Program

Date: September 14, 2016

Venue: Seminar Room B of Shiinoki Cultural Complex, Ishikawa Prefecture

10:00-12:30 morning session (Section chairs: Prof. Jie Chi Yang and Prof. Pi-Hsia Hung)

14:00-16:30 afternoon session (Section chairs: Prof. Ming-Puu Chen and Prof. Hiroaki Ogata)

Identifying the learning strategies of English collaborative listening comprehension with a context-aware ubiquitous learning system

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Abstract

Few studies have yet explored how context-aware ubiquitous learning can be used to help improve the English listening comprehension of undergraduates in non-English speaking countries. This study aimed to improve learners' listening comprehension with a combination of u-learning tools and video materials, and attempted to investigate the learning strategies used in groups. Hence, the researchers designed a Ubiquitous Fitness English Listening Comprehension System (UFELCS) incorporating collaborative listening activities. The researchers used a design process based on Design-based Research, and also conducted a mixed method design, using both qualitative and quantitative methods. The results show that the participants' learning performance was significantly improved, and that the results of the usage experience questionnaire were generally positive, although the learners did not feel that the process of scanning the QR codes generated by their teammates was easy. Moreover, the analysis of the interview data showed that the interviewees and their own teams held positive attitudes towards the creative ways of language learning, and their use of listening strategies was also disclosed. Future researchers may consider the integration of various types of computer-supported collaborative learning and hypermedia to help improve the listening comprehension of learners of different ages.

Keywords: evaluation of CAL systems, human-computer interface, interactive learning environments, teaching/learning strategies

1. Introduction

Listening comprehension has been recognized as being an important objective of foreign language learning; however, educators have indicated that most students receive insufficient listening training when learning foreign languages in their own countries [1, 2]. For example, English teaching in Taiwan focuses more on literacy-related skills within an exam-oriented system, which has been widely criticized for not equipping EFL (English as Foreign Language) learners with good communicative abilities. Consequently, the Test of English Listening Comprehension (TELC) has been used in the college entrance examinations in Taiwan since 2011, with the aim of improving students' abilities in this area. This development is based on the growing realization that listening is not only a major source of language learning, but is also the foundation of communications [3]. [4] noted that the use of the spoken language enhances interaction among learners, because any failures to understand what is heard can motivate them to work harder and engage in more interactions.

With the advent of mobile technologies such as tablets, smart phones, notebook computers, and so on, learning is now also becoming mobile. Moreover, wireless Internet connections and sensing technologies, such as QR (Quick Response) codes, have enabled context-aware ubiquitous learning (u-learning). In a context-aware u-learning environment, the learning system is able to identify the real-world status (e.g., location) of the learners via sensing technologies, and guides learners to access the right information at the right time and place via mobile devices with wireless Internet facilities [5, 6]. However, few studies have yet explored how context-aware u-learning can be used to improve the English listening comprehension of undergraduates in non-English speaking countries [5, 7].

Computer-supported collaborative learning is a form of u-learning [8] which emphasizes social interaction and knowledge construction and sharing [9]. Collaborative learning can promote higher order thinking, stimulate creativity and production, and improve the resulting knowledge acquisition and learning outcomes. In order to better promote communicative competence, learning English in a group is encouraged, and in a context-aware ubiquitous learning environment, learners can have more opportunities to interact with each other, develop problem solving skills, and achieve better learning outcomes [5; 10, 11, 12].

In order to improve listening comprehension for university students in Taiwan, the case study took advantage of mobile technologies, collaborative learning and theme-based videos to design a context-aware ubiquitous listening system. There are three research questions that are examined in this study:

1. How effective are the collaborative learning approach and theme-based videos with a focus on Fitness English listening comprehension in the u-learning environment?
2. What are learners' perceptions of the use of the Ubiquitous Fitness English Listening Comprehension System (UFELCS) in the collaborative listening comprehension activities?
3. What are the listening strategies used by groups when conducting the listening comprehension activities via UFELCS?

2. Methodology

This study made use of smartphones, QR codes, fitness machines in the Fitness Center, one learning system, a series of listening tests, and a questionnaire. Each participant was equipped with a smartphone, which allowed them to scan the QR-codes attached to the exercise machines in the Fitness Center. To advance to the next level or activity, all the group members needed to complete their tasks via generating a new QR code. Everyone scanned the QR codes obtained from the other two teammates, so that all three green lights were lit, and all of the learners could thus move on to the next task. Such a learning system design consideration aimed to keep the group members working together.

2.1. Participants

The researchers recruited thirty-six non-English major undergraduate students in their sophomore, junior and senior years at a university in Taiwan. This group was made up of 23 females and 13 males, all of whom were Chinese native speakers, and their average age was 23. All the participants had taken an intermediate–proficiency level standardized English test, such as GEPT, TOEIC, or IELTS, and they were required to present an exam certificate to prove that they were qualified to take part in the experiment. The participants were asked to form 12 groups of three; most chose to work with their friends.

2.2. Instruments

The objective of this study was to improve learners' listening comprehension with regard to the ESP topic of Fitness English. Four short videos were used for conducting eight collaborative listening activities in this study. The design of learning materials went through the following steps. In the first step, the researchers collected some relevant information and professional knowledge about fitness from books, the Internet, and physical education teachers, in order to write factually accurate dialogs for the videos. To assure the validity of the learning content, in the second step the researchers used triangulation when creating the learning materials in four stages as follows. The initial stage was to have a native English speaking proofreader examine the content, and the next stage was to revise the content based on the proofreader's advice. In the third stage, the revised version was sent to an English expert for further refinement. In the final stage, the researchers finished the content. In the third step, one male native speaker, one Taiwanese female and one of the researchers then recorded the videos. In addition, the participants were required to take a series of listening comprehension tests, and observation, interviews and one questionnaire were also used to obtain supporting data.

As for the reliability of the test, the content in three parts was examined by an English-language-teaching expert, and then the test was sent to a reliable proofreader of English. After revising the test based on the suggestions, the researchers had two English natives record the listening test and save it to a CD. Five undergraduates with intermediate English proficiency level then listened to the CD and took the test, which was then revised based on their feedback. In addition, this questionnaire with five sections was designed and adapted from the research conducted by [13], [14, 15]. More importantly, the reliability of the questionnaire was investigated, and its resulting Cronbach's alpha was 0.94, indicating good reliability.

2.3. Learning System Design

To improve the learners' listening comprehension with regard to the ESP topic of Fitness English, the videos were shown without subtitles in order to have the learners focus on listening rather than reading. The videos were filmed in an authentic setting—the Fitness Center—to help learners comprehend the materials. The content of the four units was presented in the form of filmed dialogs, since conversations make for more realistic listening material.

The Ubiquitous Fitness English Listening Comprehension System (UFELCS) works to integrate a collaborative element into learning activities. After the individual learners finished watching the videos, they worked in groups to decide when to start the learning activities, which were related to the content of the videos. They needed to collaboratively complete the learning tasks by answering a series of audio-only questions and submitting their written answers after coming to agreement on the answers. Learners were required to follow all the steps shown in Table 1. The participants were asked to complete the cycle within a week, and then repeat the cycle until the four units and learning activities had been finished.

Table 1. Learning Activity Steps for Each Group

Step	Description	Task type	Location
1	Each member uses the UFELCS system in the smartphone to watch a video.	Individual	Anywhere
2	Participants need to go to the Fitness Center to scan the QR code located at the entrance of the center. Once this is completed, participants can access the listening comprehension quiz.	Individual	Fitness center
3	Members work together to complete and do the activity/five-question listening comprehension quiz associated with the video.	Group	Anywhere
4	The UFELCS system notifies each individual member of successful task completion by showing a green light.	Individual	Anywhere
5	Group members need to scan QR codes from the other group members so that all of them have three green lights.	Group	Anywhere
6	The UFELCS system notifies each individual that they can go on to the next task.	Individual	Anywhere
7	Repeat from step 1 until all activities/tasks are completed.	Individual	Anywhere

Next, in order to gain additional information about the subject of fitness, the learners could go and scan the QR codes that had been placed in the learning environment, i.e., on the machines in the fitness center, to understand the functions for each of them. They also used their smartphones to generate the QR codes necessary to move onto the next activity. This use of QR codes enabled each learner to become an interactive human-object located in a multi-functional state, as each individual was able to generate a QR code and pass it along to the other group members. In this way, the QR codes function as both a source of information and a mechanism of collaboration (see Figure 1), and thus are sites of interactivity. Moreover, the learners are able to learn seamlessly with the aid of the sensors, and both learners and mobile devices are mutually interconnected.

Figure 1. After Finishing the Team-based Activity, a green light is lit

The other aim of the learning system was to enhance the interaction among the learners, their smartphones and the Fitness Center. The system allowed the users to watch videos after logging in, record their learning portfolios, scan the QR codes, and detail their learning pace and learning time, as well as providing an online dictionary and link to the discussion board, hosted on Twitter (see Figure 2). The design of the UFELCS learning system is shown in Figure 3.

Figure 2. Screenshot of the Online Discussion Board Hosted on Twitter

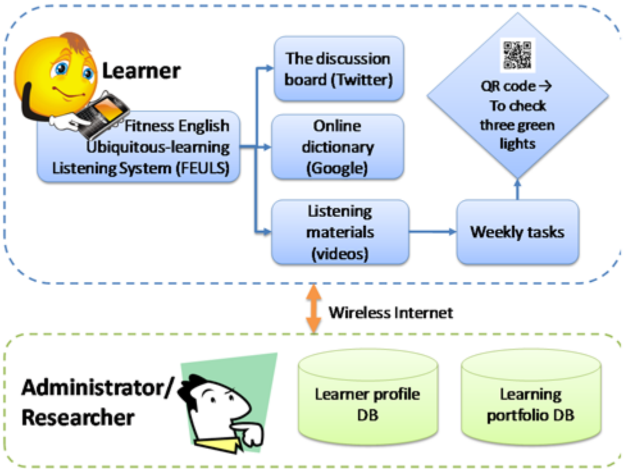

Figure 3. The Design of the Fitness English Ubiquitous-learning Listening System

2.3. Procedures & data analysis

This study employed the design-based research method [16, 17], and used both quantitative and qualitative approaches to collect and analyze the data. The researchers recruited 36 undergraduates who took an English listening pre-test. During the orientation for the students, the members of the twelve groups were confirmed, and they were also informed that they would get a reward upon completion of the learning program if they successfully adhered to the program requirements. The learners were told that they could arrange their learning at their own pace, as well as when to work collaboratively each week in the Fitness Center, from Weeks 2 to 6. After Week 6, the learners were allowed to do the learning task away from the Fitness Center in order to achieve "transfer of learning," which means they could use the learned knowledge or skill in similar situations. Each participant was required to post at least one comment on the discussion board each week. In Week 10, an English listening post-test and one questionnaire were used to examine the learners' Fitness English listening comprehension, learning experiences and technology acceptance. The researcher interviewed nine participants in Weeks 11 and 12, and individuals were selected if they were identified as "information rich" subjects [18, 19]. Based on the principles of non-probabilistic sampling, information rich subjects are those who can provide valuable information with regard to the research questions, and are thus able to yield greater insights about some specific phenomena [18]. Moreover, semi-structured interviews were employed [20], and the researcher used nine open-ended questions as interview guides. In Week 12, the participants completed a delayed test to assess their memorization of the learning materials, and an electronic product was given as a reward for completing the whole learning program.

Most of the qualitative data from the interview transcripts were analyzed based on the principles of grounded theory [21], while some field notes and the observations of the online discussion board were used as supporting data. The results of the listening tests from all the participants and the analysis of the questionnaire were the primary sources of the quantitative data. The SPSS version 19.0 statistical software was used to analyze the quantitative data, while one-way ANOVA was used to examine the differences among the learners' performances in the series of listening tests. The results of the questionnaire were analyzed using descriptive statistics, and the relationship between the students' learning outcomes and their learning experiences and perceptions were uncovered based on this.

3. Results

3.1. Results of the Learning Achievement Tests with a Focus on Listening Comprehension

The results of the listening pre-, post- and delayed tests were examined with a one-way ANOVA test, and compared to see if there were any significant differences. The descriptive data for these tests are presented in Table 2. The mean score was 67.33 for the pre-test, 76.92 for the post-test, and 84.50 for the delayed test. In addition, the mean difference between the pre- and post-test was 9.59, which showed that the participants' listening comprehension improved significantly. Further, the mean difference between the post and delayed test was 7.58, which indicated that the participants could still retain and retrieve the information they had learned two weeks after the post-test. The results of the pre-, post-, and delayed tests differed significantly, F (2,107) =34.761, p<.001. Moreover, the results of the Dunnett T3 post-hoc comparisons indicate that the post-test results were significantly higher than those of the pre-test (p<.001), and thus that the participants' listening comprehension improved after using the u-learning tools with their teammates. These findings show that the u-learning scaffolds not only helped the students improve their listening comprehension, but also helped them retain the knowledge they had learned.

Table2. Descriptive Statistics of the Pre-, Post-, and Delayed Tests

Tests	N	Mean	SD
Pre-test	36	67.33	8.77659
Posttest	36	76.92	10.38784
Delayed test	36	84.50	6.70820

3.2. Results of the usage experience questionnaire for the UFELCS learners

The researcher designed a usage experience questionnaire in order to better understand some aspects of both the learning effectiveness and learning efficiency that occurred with the use of UFELCS. The questionnaire examined five dimensions of user experience: ease of use, usefulness, system design, the content of the learning materials and overall user perceptions. First, the reliability of this questionnaire was examined, and the resulting Cronbach's alpha was 0.94, indicating good reliability. The questionnaire contained 61 items answered with a five-point Likert-scale.

3.2.1. Part one: Ease of use

The average mean score was 3.81, showing that the participants thought that the u-learning system was easy to use. The mean score of the highest ranking item, P1-2, was 4.03, and 83% of participants agreed that it was easy to operate the u-learning system. However, the mean score of P1-3 (3.69) was the lowest in this dimension, and 75% of participants thought that using the system to collaborate with their teammates was easy, while 17% disagreed with the statement that the collaboration process via scanning the teammates' QR code was easy.

3.2.2. Part two: Usefulness

The average mean score of usefulness was 3.71, which shows that the participants considered the u-learning system to be useful with regard to learning English. The mean score of item P2-13 (4.11) was the highest, indicating that 84% of the participants agreed that the Google online dictionary helped them learn English when encountering some unfamiliar words in the listening process. Moreover, the mean score of items P2-10 (3.97) and P2-11 (3.94) were both almost 4, showing that over half the participants were satisfied with the guidance mechanism and enjoyed learning with the smartphone. However, the mean score of P2-7 (3.08) was the lowest in this part, revealing that 25% of participants disagreed with the statement that the discussion board, i.e. Twitter, was useful. In addition, the mean score of item P2-1 (3.47) was below 3.5, revealing that the functions of the learning system, such as Twitter and the three-green-light mechanism were complicated for some learners. Item P2-2 (3.44) also scored below 3.5, showing that the unavailability of the wireless connection in some places could not let participants learn on the move.

3.2.3. Part three: System design

The average mean score of 3.76 indicates that the participants were quite satisfied with the design of the system. The mean score of item P3-1 (4.03) was the highest, showing that 81% of the participants agreed that they enjoyed learning in the real context, and this enhanced the efficiency of learning Fitness English. However, the mean score of item P3-4 (3.42) was the lowest, showing that 22% of the participants disagreed with the statement that the mechanism used for collaboration, i.e. scanning the QR codes generated by their teammates, was easy for them to use.

3.2.4. Part four: The content of the learning materials

The average mean score of this part was 3.94, indicating that the participants tended to enjoy learning the contents of the materials used in the system. Moreover, in Table 4.10, the mean score of item P4-6 (4.17) was the highest, indicating that 94% of the participants agreed that the use of videos and the weekly learning tasks helped them learn better. Nevertheless, the mean score of item P4-2 (3.61) was the lowest in Part four of the survey, with 8% of participants stating that better quality learning videos were needed, along with more varied learning units.

3.2.5. Part five: Overall user perceptions

The average mean score was 4.04, showing that the participants had positive attitudes toward the learning process used in this intervention. The mean score of item P5-5 (4.61) was the highest, indicating that 97% of the participants strongly agreed that their problems were solved immediately by the researcher. Furthermore, the mean scores of items P5-2, P5-3, P5-6, P5-9, P5-10, P5-12, P5-13, and P5-14 were all higher than 4, showing that over 80% of the participants enjoyed learning English with the u-learning system and working with their teammates. However, the mean score of item P5-4 (3.56) was the lowest, indicating that 22% of the participants still did not think that scanning the QR codes generated by their teammates was easy.

4. Conclusion

The participants held positive attitudes toward the instruction and the learning system, and their listening comprehension improved significantly in this case study. With the use of wireless Internet and smart phones, learning was more flexible and took place in an informal learning setting, and the students had better learning and creative outcomes. In addition, with the u-learning support, the participants showed significant improvements in their listening comprehension, based on the quantitative data, which echoes the studies of [5] and [7]. Moreover, the use of videos also increased the students' learning motivation and improved their listening comprehension.

The findings of this work show that in the collaborative learning approach, the learners more frequently adopted cognitive, metacognitive and social strategies, with "analyzing and reasoning the learning materials as a cognitive strategy", "arranging and planning your learning as a metacognitive strategy" and "asking for clarification and verification as a social strategy" being most often used.

The learners' use of listening strategies was also disclosed. However, learners should be taught or suggested to adopt other language learning strategies which were found to be the least used in this study to enhance their learning performance. Further, the mechanism of collaboration used in the u-learning system was interesting for the learners, but demonstration should be made more clearly. Future researchers may consider the integration of various types of computer-supported collaborative learning and hypermedia to help improve the listening comprehension of learners of different ages.

Acknowledgements

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Diminishing Gender Difference in Communal-Collaborative Learning

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Abstract

In the study, gender difference of spatial ability was diminished in a collaborative and game-based learning program spanning 14 hours in five weekends. Using ANCOVA (analysis of covariances) to adjust for pre-test score difference statistically, there was no longer gender difference in the post-test score, and the adjusted post-test mean score for girls was even slightly larger than that for boys.

The collaborative component of the program was congruent to girls' communal-goal orientation which was hypothesized to be one of the major factors relating to their pursuit of STEM (Science, Technology, Engineering, and Mathematics) careers. The result of the study provides an important base for observing and diminishing gender difference in implementing technology-enhanced collaborative learning environment where the affective-social aspect would be of critical consideration.

1. Introduction

The underrepresentation of women in STEM (Science, Technology, Engineering, and Mathematics) careers is a focus of long-standing concern world- wide [1, 2]. Although several factors have been shown to contribute to this underrepresentation, such as self-efficacy, differential encouragement, and social stereotypes, Diekman et al. [1] proposed a new perspective on this issue by hypothesizing that career interest/choice is the intersection result of people's goals and the careers' perceived goal endorsement along the agentic-communal dimensions.

Power, achievement, and seeking new experiences or excitement are affiliated with the agentic goals, whereas intimacy, affiliation, and altruism are more affiliated with the communal goals [3]. Men are traditionally more agentic-oriented, and women, communal-oriented, and careers can also be characterized by the agentic vs. communal goal endorsement. Diekman et al. [1] hypothesized that people tend to pursue the careers that can be preconceptualized as endorsing and matching their personal goals.

The results of factor analysis in Diekman et al. [1] showed that the STEM careers are more agentic-oriented, and communal-goal endorsement (negatively) predicts STEM interest above and beyond self-efficacy, even though self-efficacy is a robust predictor of STEM interest. Similarly, a meta-analysis of job attributes preferences showed that the largest gender differences are women's greater preference for helping other people and working with people [4]. Diekman et al. [1] reasoned that STEM careers as being perceived to impede communal goals, if women are communal-goal oriented and perceive STEM as antithetical to their goals, it is not surprising that even women talented in these areas might choose alternative career paths. Therefore any intervention to improve girls' attainment in STEM courses would fail to increase their STEM participation if the above mentioned affective-social preconception is not taken care of [1, 2]. It is then necessary to demonstrate to girls and young women how STEM can help and collaborate with people, and be fun as well.

2. Method

A pilot intervention was implemented with primary school children of grades 4-6 in a weekend camp to promote spatial ability, an ability that is much related to STEM [5] and is malleable in earlier ages [6]. Several research has shown that children and adolescents who have higher spatial skills in middle and high schools are more likely to major in the STEM disciplines in colleges and to pursue STEM careers [such as 7, 8].

The five-weekend program included 14 hours of lessons playing with cubes and puzzles, pre- and post-tests of spatial ability, and a final presentation of children's creative making of cube combinations. Children were divided into teams so that they worked with team members and earned credits for their teams through all the activities and the final presentation.

2.1. Participants

There were 19 boys and 9 girls with complete attendance and test data. This size of sample is usually regarded as small, especially the size of girls. However, it may reflect a typical ecology of gender distribution in STEM related courses and activities that girls' presence is much smaller than that of boys. Moreover, some girls participated in the camp just because their brothers registered to attend and their parents wished they could go along with their brothers. As a result, the camp members in the pilot study can be deemed as a normal constitution of genders in STEM related programs in terms of the size and distribution.

2.2. Instrument

The paper-and-pencil standardized spatial ability [5, 9] was used as the pre-test and post-test. There are 18 multiple-choice items, making the total test score 18. The test reliability is .819.

3. Result

3.1. Descriptive statistics and normality

Due to the small sample size, the normality of score distribution is examined first before proceeding with further statistical analyses. According to the descriptive statistics of test scores (Table 1), the normality of the test scores is sustained because all the values of skewness and kurtosis are well within ±1 [10].

Table 1
Descriptive statistics of pre- and post-test scores

Test	*N*	*Mean*	*SD*	Skew.	Kurt.
Pre-test	28	9.46	.74	.74	.07
Post-test	28	12.32	3.24	-.21	-.21

3.2. Gender difference

As seen in Table 2, there is a significant gender difference in pre-test, showing that boys outperformed girls. After the five-week program, the mean scores of boys and girls both increased and boys still outperformed girls, but the gender difference disappeared in post-test.

Table 2
Gender difference of pre- and post-test scores

Test	Gender	*N*	*Mean*	*SD*	*t*	*df*	*p*
Pre-test	Boys	19	10.37	4.00	2.59[a]	25.94	.016
	Girls	9	7.56	1.74			
Post-test	Boys	19	12.53	3.61	.48	26	.636
	Girls	9	11.89	2.42			

Note. "a": Non-homogeneous *t*-value.

3.3. Growth difference

Table 3 shows the results of growth in each gender, the within-group difference in the pre- and post-test scores. The dependent *t*-analysis shows that the growth is significant in boys as well as in girls, however girls increased (4.33) more than boys (2.16).

Table 3
Dependent t-analysis of growth in pre- and post-test scores

Gender	*N*	Pre-test *M (S.D.)*	Post-test *M (S.D.)*	*t*	*p*
Boys	19	10.37(4.00)	12.53(3.61)	-2.55	.020
Girls	9	7.56(1.74)	11.89(2.42)	-4.11	.003

3.4. ANCOVA

Since girls and boys were different before beginning the program as shown in their significant difference in pre-test scores, it is worth of removing the pre-test difference statistically, and then observing if the gender effect would be remaining. Using the pre-test score as the covariate (Table 4), the gender difference in post-test is no longer significant, given that the homogeneity of regression coefficient in covariate within-group is sustained as well as the homogeneity of variances. It deserves to note that with ANCOVA procedure, the adjusted post-test mean score for girls (12.71) is even larger than that for boys (12.14).

Table 4
One way ANCOVA of gender difference in post-test

Source of variation	*SS*	*df*	*MS*	*F*	*p*
Pre-test/ covariate	58.18	1	58.18	6.51	.017
Gender	2.48	1	2.48	.28	.603
Error	223.44	25	8.94		
Total	284.11	27			

Note. Adjusted R^2=.151

4. Discussion and conclusion

Given the sample though small yet typical of gender distribution in STEM related activities, the results are summarized as follows:

a. Before the intervention program, there was significant gender difference in spatial ability favoring boys;
b. After completing the 14-hour program lessons in five weekends, both boys and girls improved their test scores in post-test, showing that the

intervention is effective in improving their spatial ability;

c. Both the within-group growth/increase of girls and boys are significant;

d. But girls' growth is larger than that of boys so that in post-test there was no longer gender difference, further indicating that the intervention is effective in reducing gender difference.

Of most importance and interest is that the intervention helps to promote girls' spatial performance so that they are comparable with boys in just 14-hour, five-weekend program, even when they are surrounded by more boys. Of course further investigation would be necessary to follow the line of research and provide more explanations of insight into this promotion effect, with a larger sample. However, the component of collaborative learning in the intervention deserves special attention. Moreover, other subject matters, either of STEM or non-STEM, may be experimented to see if the same diminishing effect of gender gap is existent.

STEM careers are usually perceived as working alone with "cold and lifeless" equations, machines and equipments, quite contradictory to the communal-goal orientation which is to care about, work with or help people. It can be extended from the result of the study that, if girls are encouraged to participate in STEM related activities, their potential is quite beyond imagination. But what matters is the design of the program activity. The program design in the pilot study was enriched with joyful collaborative learning. In a similar vein, it can be further extended and expected that gender difference be diminished in technology-enhanced collaborative learning if it is well endorsed with communal-goal orientation to help and work with people.

One more implication in the study is that early intervention is important! Do not wait until too late to encourage girls in pursuit of STEM paths. The snowballing effect [2], as gender gap is being reduced at gateways and girls accumulate early even though small improvements over time, may encourage them to persist in STEM fields and turn out to set long-term academic and career trajectories for women.

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Applying Big data analytics to MOOCs learners' adaptive course material recommendation

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Abstract

Massive Open Online Courses (MOOCs) are the road that led to a revolution and a new era of learning environments. However, MOOCs usually pre-made learning materials before class. The learners may have insufficient prior knowledge and cannot understand the learning contents easily. When the learners can not realize the learning contents, MOOCs do not provide immediate feedbacks and learners do not know how to start. Therefore, this study presents adaptive course material recommendation service, which not only passes on original knowledge in the classroom, but also helps students learn related social knowledge. Additionally, an expectation experiment was conducted to explore the influences of the adaptive course material recommendation on MOOCs learners' learning performance and behavior patterns. Pre-test and post-test were applied to assess students' learning performance while a lag sequential analysis was used to analyze behavior patterns.

1. Introduction

With the widespread of Internet and the prevalent of cloud technology, all of people's operation process on the Internet will be recorded. Researchers no longer put their focus on the technology techniques and the development of tools. They want to exact and read the abundant information from the huge amount of data, and get people's opinions of things to predict the future direction and take the preemptive opportunities. The trend to use large amount of data to analyze, evaluate and predict to make decisions are called Big Data analytics. Big data analytics not only has influence on current industry and commerce but also influences digital learning gradually [1].

In the past seven years, Educational Technology witnessed the start of an era for courses of a new type which are massive in terms of student numbers, open for all and are available online. This new type is known as Massive Open Online Courses or more commonly by the abbreviation MOOCs. The term MOOC was first coined in 2008 by David Cormier. The MOOCs objectives thus varied between saving costs and/or increasing revenues, improving educational outcomes, extending the reachability as well as accessibility of learning material to everyone and also providing support for the Open Educational Resources Movement [2][3].

Therefore, many researchers propose to collect large amount of learning behavior data in a long time and analyze them by Big data analytics to enhance students' learning effectiveness. In addition, some researchers point out that Big data analytics can be applied to educational administration and teaching applications [4][7]. In educational administration, Big data analytics can help staffs the recruiting works, financial planning, donations tracking and students' behavior monitoring. In teaching application, Big data analytics can help teachers predict whether a student will drop out, whether students need extra help or whether they can face harder challenges, etc. Thus, using Big data analytics to predict education development is worth promoting [6][11].

This study will use Big data analytics to achieve adaptive materials recommended services to promote MOOCs learners' learning performance and explore behavior patterns. Furthermore, the adaptive materials recommendation service will first collect MOOCs materials and current news through Big data analytics development process to hyphenation words that achieve word matching and word frequency analysis. In addition, through the adaptive materials recommendation service, learners' information overload about the courses will be reduced.

2. Big data analytics development process

This study design service development process, as shown in Figure 1, the service development process encompasses the following four steps, namely data collection step, data storage step, information extraction, and information application.

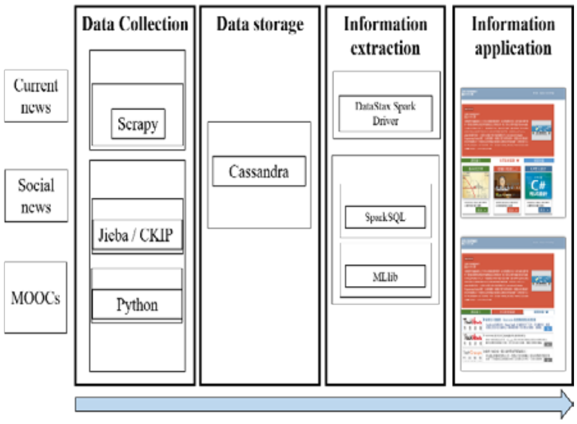

Figure 1. Big data analytics development process

- Step 1: Data collection

The data on MOOCs are crawled and saved to the raw database. After, the user behavior data and the discussions and feedbacks of popular courses are learned by the machine, the statistical data are saved to the processed database. In addition to crawling and transforming the semi-structured data on MOOCs, this research will design smart Web Crawler to crawl and transform the social networks, forums and blogs on MOOCs. Now, most data on Web 2.0 websites and forums are unstructured data. Therefore, large artificial training parser or page information selector is used to intercept the specific data. The smart Web Crawler is executed on the cloud devices that are rented and it can crawl large data instantly and transform effectively. After testing and developing several frame and tools, Phamtom JS and Scrapy are chosen to be the core technique to crawl and transform data.

- Step 2: Data storage

Owing that the data that is collected from the courses, portfolios, social medias, forums and blogs on MOOCs are different, it is ineffective to set up different data format for individual websites and may be difficult to handle the follow-up data. Our research adopts Apache Hadoop and provides non-relational database (NoSQL, Not Only SQL which is different from the traditional relational database management system) on Hadoop's HDFS, Hbase and Hive to be the original database architecture. This architecture can instantly search, process and analyze the data and provide precise results. Non-relational database does not need the definition of the scheme of data before they are saved. Compared to relational database, non-relational database is much scale-out and has the advantage of efficacy in response to the Big data analytics. To solve the problem of non-relational database that the larger the database is, the lower the storage efficacy will be, the database storage will adopt Cassandra [9].

- Step 3: Information extraction

This research uses international free Big data analytics software, Spark and MLlib. Spark and MLlib support Apache Hadoop to promote high effective disperse machine learning and data mining. The various machine learning methods may help to find out the meaningful data hidden behind the Big data or provide the data that is suitable for the users or entrustment institutions to refer to or apply. Machine learning and data mining can be applied in many aspects. The data crawled from social networks and forums may use machine learning algorithm to do grouping and classification. The data on the websites and forums can provide general classification concepts. Data mining and statistics can be done to the social network comments to get the popular discussion and the related learning issues [4][10]. The data are crawled and transformed based on the needs of teachers and decision makers. Then, related machine algorithm is used to the transformed data and the result will be saved into Cassandra.

- Step 4: Information application

The data on MOOCs that are processed by Big data analytics will be presented by graphical user interface. In this way, users can know the rich meanings and values of data by the easy-to-use management interface. Because of the rich data and interactive functions, webpages are chosen to be the interface of data visualization. For the techniques of webpage visualization, this research adopts Bootstrap + D3.js to be the frame and tool of front-end application. The past user experience data of MOOCs teachers and learners includes text, social network, related connections, information flow, etc. After machine learning and data mining, the visualized user interface will present the key person, event tracing, popular keywords, and the relationship graphs of people and event, etc. The visualized data will provide graphic user interface that is easy-to-use for teachers and the decision makers to grasp the statistical data and trend of Big data analytics on MOOCs and students' learning conditions, shown as Figure 2 and Figure 3.

Figure 2. Recommend more material

Figure 3. Relation News recommend

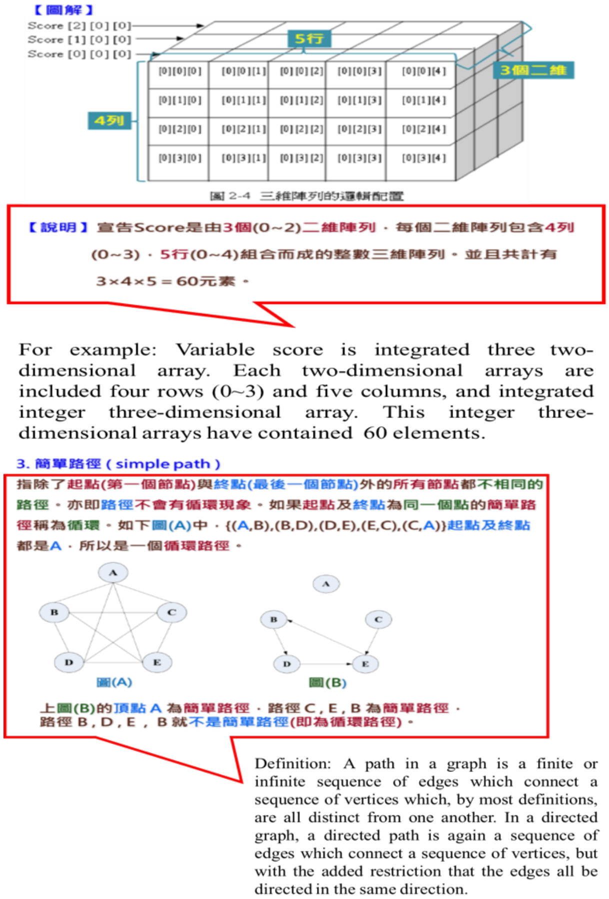

Figure. 4：Experiment material

3. Experiment design

The study participants comprised 80 students at an college located in Northern Taiwan. The participants ranged between 20 and 21 years of age and were recruited from two classes. One class served as the experimental group and the other class served as the control group. The two classes were taught by the same teacher. Eventually, 40 students were assigned to the experiment group while 39 students were allocated to the control group. Regarding the course material, as shown in Figure 4. This course was designed for teaching how to use the C# to develop efficiency algorithm for desktop computer. Because most of the participants do not have experience in writing program with the C#, comprehensive information is covered in this course, including “introduction C#”, “basic program skill”, and “conduct a C# project”. The learning objectives include the understandings of the syntax of C#, learning the debugging skills, and programming with the C# statements to complete specified projects. To enhance the reliability of the results, all of the students were taught by a same tutor, used the same learning materials and were given same assignments [5][8].

3.1 Experiment procedure

In this study, experimental environment for three hours a week after school courses and four times to discuss operational activities area, a total of 16-week course. Teach the content and progress of the classroom are all in accordance with the instruction by teaching mode. The first weeks of classroom activities, teaching activities are scheduled to announce planning, reporting and payment time performance rating method, prior to the event to investigate learners experience MOOCs platform. The first two weeks of classroom activities, each learner will be assigned to the job tasks, such as: Introduction to serial link is defined, the linked list can be divided into several Introduction and Definition of complete binary tree of other issues. Learners can discuss with their peers through discussion forums MOOCs platform on issues related to answer questions and find information in the first six weeks of classroom activities, learners start watching videos MOOCs courses on the platform, and then arrange the second task cooperative job, respectively 7 weeks and 11 weeks. Finally, in the first 15-16 weeks of class time, so that learners report job sequentially theme itself is responsible and involved in the experience.

3.2 Experiment tool

Traditional measurement tools used in this study contained before learning performance test, measurement and performance after learning motivation, self-efficacy and science learning community questionnaire. Former academic performance measured aimed at evaluating all activities of two groups of students participating in the experiment have the same prior knowledge of the topic contains 25 multiple choice questions, out of 100; after learning performance test for the purpose of assessment for students Introduction to Computer level of understanding of the characteristics and concepts, topics and contains 25 multiple choice questions with 10 out of 100 points. Two test volume by two to teach Introduction to the computer for more than 10 years of teachers to the topic. The motivation questionnaire, this study modified from Hwang, [13] proposed the motivation questionnaire.

In addition, the study is expected to science learning assessment questionnaire students' learning methods and strategies. Science learning questionnaire adapted from [12] the development of science and learning scales, this table contains deep motivation, deep strategy, shallow and superficial motive for the four strategies: a deep motivation: the tendency of students active learning, no extrinsic reward and heartfelt love learning. 2. Deep strategy: Students tendency through understanding, and related concepts links way to learn. 3. Shallow motivation: student attitudes toward learning to focus on the level of test scores. 4. Shallow strategy: Students with a tendency to memory, read-only exam-focused strategy to learn.

4. Conclusion and further work

This research was built upon a combined framework of Big data technique to support the teachers in carrying out a feasibility study on MOOCs. This research also explored and analyzed students' learning performances. The experiment results show that the post-test scores of experimental group were not as good as that of the control group. The result of a previous research indicated that, no matter how advanced the learning tool is, there will be no significant improvement in a student’s learning performance without an effective teaching strategy [13][14]. Therefore, the experiment results of this study show that there is no significant change in experimental group and control group's learning performance. In future works, the researcher suggests that the design of learning activities could be expanded to more disciplines and to situational application related technologies, such as augmented reality, context awareness, and physiological awareness.

Acknowledgements

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Improving Learning Achievements, Collective Efficacy and Flow with a Collaborative Mobile Role-Playing Game

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Abstract

In this study, a collaborative mobile role-playing game was developed for designing a context-aware ubiquitous learning system so as to engage students in the real-word learning activity. An experiment was conducted in an elementary school natural science course for assessing the effects of the proposed approach on students' learning achievements, collective efficacy and flow. The experimental results presented that this collaborative mobile role-playing game can effectively promote the students' learning achievements, collective efficacy and flow in comparison with the conventional collaborative ubiquitous learning.

1. Introduction

A great deal of research has asserted that integrating wireless communication and sensing technologies can facilitate students' learning in an authentic environment [1]. On the other hand, learning in such complex learning scenarios is a challenge; for example, [2] described that inefficient learning may be taken place by improper applications in these learning scenarios.

Collaborative learning, a kind of learning support approach, is regarded to the methodology for assisting students in collaboratively completing tasks [3]. A collaborative learning activity, if appropriately planning, can make a great contribution for engaging students in active problem solving [4], indicating the significance of their team endeavor.

Consisting of some enjoyable elements, digital game-based learning (DGBL) can trigger students in a challenging activity [5]. Moreover, role play provides an environment for engaging students in a learning activity or problem-solving task via situating them in experiential learning [6]. Thus, in this study, a collaborative mobile role-playing game is developed to improve students' learning effectiveness.

2. Literature review

2.1. Computer-supported collaborative learning

Integrating computer technologies with collaborative learning has led to a pedagogical methodology, called computer-supported collaborative learning (CSCL) [7]. A CSCL environment can improve students' information sharing and opinion expression, based on the technology provided for a team to communicate with each other.

Although CSCL can facilitate teachers to implement a collaborative activity, the way to facilitate students' interaction is still being investigated. By way of illustration, [8] indicated that only about half of the participants actively shared information in an online shared workspace. On the other hand, collective efficacy, one of the most powerful group motivation beliefs, refers to as the effort that the team members put into their team endeavor [9]. Since the processes of team interaction are particularly related to collective efficacy [10], it is worth probing into a team's collective efficacy during the collaborative learning activity.

2.2. Mobile game-based learning with role play

Digital game-based learning (DGBL) is regarded as the integration of the entertainment of digital games into a learning context [6]. DGBL consists of some enjoyable elements (i.e., feedback, goals, competition, rules, interaction and control) in order to engage students in a challenging learning task [5].

DGBL can provide a meaningful context for the problem-solving learning activity [6]. For instance, [11] integrated a learning strategy into an education game for urging students' collaboration. Moreover, combining digital games with mobile learning, mobile games can promote students' learning effects, by engaging them in a learning activity in a real-world environment [12].

Role play situates students in experiential learning, providing an environment for problem solving and engagement [6]. During a role-playing activity, an individual plays a role in a compelling story with some aspect of human interaction, which particularly profits the complex social systems in the learning situation. For example, [13] indicated that role play may improve students' learning and scientific attitudes via providing a more authentic learning environment.

A well-designed game can promote students' flow, which can lead to satisfying enjoyment and intensive. Meanwhile, a pleasant experience can trigger students to endeavor in the activity [14]. It is worth investigating the students' flow during the learning activity.

In this study, a learning system with collaborative mobile role-playing game is developed for assisting students in completing the learning tasks in the real-world learning park. Moreover, an experiment has been conducted to explore the influences of this system on their learning achievements, collective efficacy and flow.

3. A collaborative mobile role-playing game

In this study, a real-world gaming environment was developed by using mobile and cloud computing technologies. The structure of this environment contains three mechanisms, namely the "real-world gaming mechanism", the "collaborative mechanism" and the "cloud technology-based learning portfolio management mechanism". Moreover, a real-world gaming learning system was developed adopting Visual Studio C# and Android Studio. QR codes were designed to affirm students' physical location.

A collaborative mobile role-playing game was designed based on the concept of "biology and environmental science" and a learning park in an elementary school. Gaming tasks facilitate students to explore the influences of pollution on biology and environments. The gaming story is concerned with the island country, which is rich in natural resources and shelter. However, owing to excessive energy usage, the shelters are weakening. In the same time, a witch takes the opportunity to smuggle in a great deal of invasive species to destroy the ecological balance. Therefore, the king enlists some braves to explore the environmental and ecological changes and attempt to solve the problems. The map, which is drawn in accordance with the real-world learning park in the elementary school, directs students in the collaborative mobile gaming tasks. The main game interface is depicted in Figure 1.

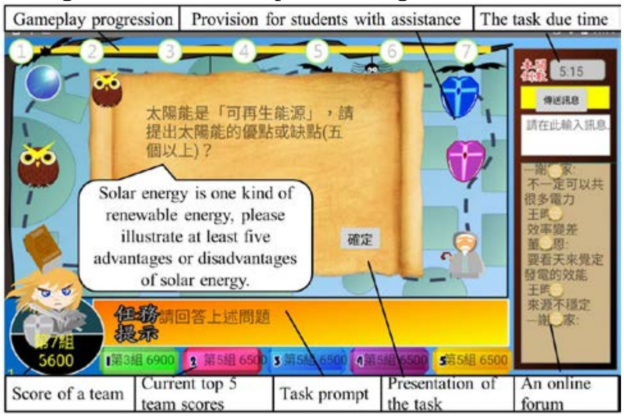

Figure 1. Interface of the gaming system

When logging into the learning system, a team can choose and freely challenge one of the six game stages. After six stages are completed, the last state, called "Honor Battle", is initiated automatically. In each stage, the team has to depart for the location, which is with reference to the game stage, in the learning park. Once the game stage is touched, the story and a gaming task will be presented to trigger the team to complete the learning activities by searching learning materials, providing the clues, and conducting field observations. For example, when a team challenges the "Honor Battle", a compelling storyline is shown: "By reason of excessive energy usage, the island has been in a state of chaos: thus, the island is in urgent need of renewable energy." Subsequently, a gaming task of the problem-solving activity is described (see Figure 1): "Solar energy is one kind of renewable energy, please illustrate at least five advantages or disadvantages of solar energy."

In order to facilitate the team to accomplish the task, some assistance is provided, such as a sage, a blue shield, a red shield, a crystal ball and a treasury of knowledge. If a player contacts with the sage, he/she can have some key clues; the treasury of knowledge provides the learning materials about the relationship between the creature and environment, while the crystal ball supplies the players with a web search engine to look for the solutions to the task on the Internet; Once the blue shield is touched, the learning system guides a team to observe the key attributes of the creature or environment; the red shield prompts them to observe the opposite attributes of a comparative creature or environment.

Furthermore, a QR code guides the student finds the right target in the real-world learning park. As depicted in Figure 2, when the blue shield is struck, the information is shown: "Please carefully observe the digital number and information on the solar energy data dashboard."

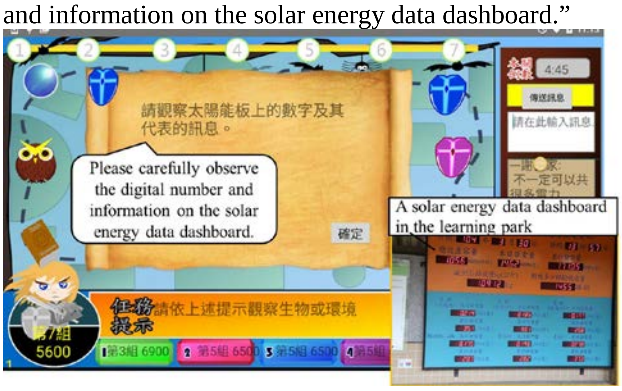

Figure 2. Key attributes provided by the blue shield

After a team offers the solutions, they have to complete two tests within a further 5-minute period. One is a basic test regarding the features of the creature or environment and the other is a comparative test concerning the comparison between two creatures or environments. Figure 3 describes the comparative test: "Which one has different type of energy from the others?" If a team submits an incorrect answer, they can submit another one. The earlier the right answer is submitted, the more points the team earns.

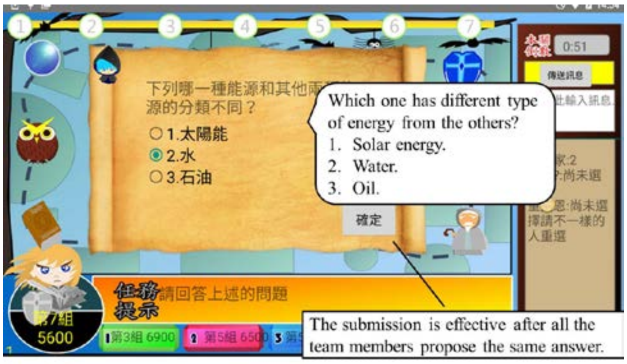

Figure 3. A comparative test

After a team completes a task, a compelling storyline about winning this stage battle is illustrated. When a team completes this last "Honor Battle" stage, the witch is beaten and the game is accomplished.

4. Method

4.1. Participants

In this study, 51 fifth grade participants were from two classes. One class (n=26) was the experimental group using the collaborative mobile role-playing game, while the other class (n=25) was the control group adopting the conventional collaborative ubiquitous learning.

4.2. Experimental procedure and data collection

A regular two-week course on biodiversity conception was implemented first. Following that, all participants took the pre-test regarding the knowledge of biodiversity and filled out the pre-questionnaire about their collective efficacy. Afterwards, the experimental group conducted the collaborative mobile role-playing game (see Figure 4), whereas the control group completed the activity through the conventional collaborative ubiquitous learning. Finally, all participants had the post-test and filled out the post-questionnaires of the collective efficacy and flow.

Figure 4. The scenarios of the learning activity

4.3. Measuring tools

The pre-test was used to evaluate all students' fundamental knowledge of "creatures and environment". It comprised 20 multiple-choice items. On the other hand, the post-test consisted of 26 multiple-choice items (78%) and four short answer questions (22%). Both tests were developed by two experienced elementary school science teachers and gave a total score of 100.

The collective efficacy survey was adopted based on modifying the questionnaire developed by [10]. It comprised eight items using five-point Likert item. The Cronbach's α value posed by the original study was 0.92.

The flow survey was designed based on modifying the measurement developed by [15]. A total of 8 items made up the questionnaire with a five-point Likert scale. The Cronbach's α value shown in the original study was 0.82.

5. Experimental result

5.1. Learning achievement

After verifying that the assumption of the homogeneity of the regression slopes was passed (F = 0.001; p > 0.05), the ANCOVA was performed. As described in Table 1, the difference between the experimental group and control one was significant (F = 6.17, p < 0.05). Thus, it was confirmed that the students (adjusted mean = 85.64) who learned with the collaborative mobile role-playing game outperformed those who learned with conventional collaborative ubiquitous learning (adjusted mean = 78.51) in terms of improving their learning achievements.

Table 1. The results for students' learning achievement

Variable	Group	N	Mean	S.D.	Adjusted Mean	Std.error	F
Post-test	Experimental group	26	84.81	8.49	85.64	2.03	6.17^{*}
	Control group	25	79.36	13.52	78.51	2.07	

$^{*}p < 0.05$

5.2. Collective efficacy

The homogeneity of the regression was confirmed with F= 0.21 (p > 0.05). Table 2 illustrates the significant difference in collective efficacy between the experimental group and control one (F = 7.76, p < 0.01); moreover, the adjusted mean values of the collective efficacy ratings were 4.35 and 3.84 for the experimental group and the control one, respectively. Thus, the collaborative mobile role-playing game can urge students' collective efficacy in a real-world ubiquitous learning activity.

Table 2. The results for students' collective efficacy

Variable	Group	N	Mean	S.D.	Adjusted Mean	Std.error	F
Post-test	Experimental group	26	4.31	0.52	4.35	0.13	7.76^{**}
	Control group	25	3.90	0.90	3.85	0.13	

$^{**}p < 0.01$

5.3. Students’ flow

A *t*-test was performed to explore the influence of collaborative mobile role-playing game on students’ flow. As shown in Table 3, a significant difference in flow was verified between the two groups with $t = 2.41$ ($p < 0.05$). The mean of the students’ flow ratings for the experimental group was 4.34 whereas that for the control group was 3.86. It was proved that the flow of the experimental group was significantly higher than that of the control group, indicating that the collaborative mobile role-playing game can effectively promote students’ flow in the ubiquitous learning activity.

Table 3. The *t-test* result for students’ flow

Group	N	Mean	S.D.	*t*
Experimental group	26	4.34	0.60	2.41*
Control group	25	3.86	0.81	

* $p < 0.05$

6. Discussion and conclusions

From the results, it is concluded that the mobile role-playing game can significantly enhance students’ learning achievements, collective efficacy and flow via effectual integration of gaming storyline and the learning contexts.

The collaborative mobile role-playing game can effectively promote students’ flow. This complies with the view stated by several researchers, who illustrated that a challenge mobile game can promote students’ flow experience, and flow experience can trigger individuals to actively engage in interacting with the environment [15]. Moreover, the online environment enabled the students to collaborate, which could be another reason why the collaborative mobile role-playing game can facilitate the students’ collective efficacy [9].

With regard to the relationship between collective efficacy and learning achievements, [7] asserted that the quality of the team collaboration is affected by members’ engagement. [9] also indicated that perceived collective efficacy can trigger team’s motivational commitment to their tasks and accomplishments. By reason of the higher collective efficacy, it is reasonable to the finding that the collaborative mobile role-playing game can enhance students’ learning achievements. Such a finding is consistent with [10]’s findings which described that collective efficacy can significantly stimulate team’s devotion to accomplish their tasks and improve their collaborative performances.

This research provides a good illustration for designing and implementing a mobile role-playing game to improve students’ learning in the ubiquitous learning activity. Furthermore, some prompt mechanisms are provided for guiding students to completing the tasks in this research, it would be interesting to further compare diverse effects of the prompts on different learning-style students.

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Effects of an Intercultural Collaborative Inquiry Approach on Students' Learning Strategies and Motivation and Perceptions of Collaboration

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Abstract

The purpose of this study was to investigate the impacts of integrating 5E inquiry-based instructional model into intercultural education, called intercultural collaborative inquiry approach, for the intercultural project "Building a sustainable city." An experiment with repeated measure design was utilized to evaluate the effects of the intercultural collaborative inquiry approach on students' learning strategies and motivation and perceptions of collaboration. The findings showed that this approach can not only significantly improve students' deep learning strategies and their perceptions of collaboration but also essentially promote their deep learning motivation.

1. Introduction

With the development of information and communication technology, intercultural communication with people around the world has been more convenient. Some countries have devoted more funds to international education. Although international exchange activities are prevalent in primary and secondary schools in Taiwan, students' international awareness and literacy still need to be improved [1]. Therefore, it is significant to promote global citizenship in the classroom.

Global education is referred to as the pedagogical concepts about the realities of globalized world, and has been well-developed since 1980s. However, some important global themes and issues, such as globalization, interdependence, peace and conflict, and sustainable development are fading away from formal education [2]. [1] indicated that the international education in Taiwan focuses mostly on international exchange activities but lacks the curriculum development, teacher professional development, and school internationalization. Thus, this study involved the issues centered around the theme of sustainability in an intercultural project

Through intercultural communication practice, students develop the skills to communicate with other with distinct linguistic and cultural backgrounds [3]. Collaborative learning refers to as a strategic tool for knowledge management and experience sharing and has been a fundamental dimension of interculturality due to the complexity of the intercultural dimension [4]. By way of illustration, [5] indicated that the international collaboration can enhance students' intercultural competences.

As regards collaborative learning, inquiry-based learning refers to a learning activity or strategy of understanding about the authentic world by means of observation, hypotheses, exploration, validation and explanation for everyday situations students confronted [6] [7]Inquiry-based learning carries some potential advantages. Students are encouraged to utilize high-order thinking and engage in their learning [8].

The BSCS 5E Instructional Model is one of the inquiry learning approaches, which is composed of five phases, namely engagement, exploration, explanation, elaboration, and evaluation [9]. The 5E Instructional Model is a learner-centered learning and stimulates students' learning motivation and performances in science education [10].

In this study, based on the intercultural collaborative inquiry approach, an experiment was conducted in a project in an elementary school so as to investigate the effects of the proposed approach. The research questions of this study are described below.

1. Can the intercultural collaborative inquiry approach benefit the students in terms of promoting their learning strategies?
2. Can the intercultural collaborative inquiry approach trigger students' learning motivation?
3. Can the students demonstrate a higher collaboration competence after learning in the project based on intercultural collaborative inquiry approach?

2. An intercultural collaborative inquiry approach with 5E instructional model

In this study, an intercultural collaborative inquiry approach, which integrating 5E inquiry-based instructional model into intercultural education, was designed for the intercultural project, namely "Building a sustainable city." In this project, the students discussed the environmental issues with their international peers under the instructional model of the 5 E's (5E Inquiry-Based Instructional Model). The project included the following phases:

Phase1. Engagement

After the teacher introduced the project briefly to the students, they had the first video chat with their international peers from India who not only introduced themselves but also their posters about how to make the environment more sustainable (see Figure 1). The purpose of this contact is to get the students' interest in intercultural communication and environmental issues.

Figure 1. The first video chat with the Indian students

Then, through the interactive multi-media platforms "Nearpod" and the online learning journal "Seasaw," the students evaluated how much they'd already known about Taiwan and climate change, which could motivate them to explore their own culture and sustainability issues (see Figure 2).

Figure2. Students assess their understanding about sustainability issues via Nearpod and Seesaw websites.

Phase 2. Exploration

Students were guided to do the exploring tasks that were built on their emerging interest in intercultural communication and climate change. As shown in Figure 3, through group discussion and collaboration, they explored the buildings, transportation and food in Taiwan and analyzed the infographics of climate change.

Figure3. Students explored their cultural and sustainability issues.

Phase 3. Explanation

In this phase, students were expected to explain their culture and what they've learnt about climate change to their international peers in the second video chat (see Figure 4). Before then the students worked in groups to help each other to practice pronunciation and fluency. The teacher also had students have letter exchange with their international peers to make sure every student has the opportunity to express their thoughts and feelings for building up intercultural communication. .

Figure 4. Students discussed sustainability issues with their international peers in the video chat.

Phase 4. Elaboration

To help the students develop deeper and broader understanding of the concepts about how to make the environment more sustainable, the students and their international peers took action to reuse and reduce many waste items in school. The students made dishwashing liquid from orange peelings and their Indian international peers had a fashion show on the theme 3Rs - Recycle, Reduce and Recycle. Later they shared their activity photos to each other (see Figure 5).

Figure 5. The students shared their action project with their international peers

Phase 5 Evaluation

At the end of the project, the students and their international peers assessed their understanding about how to make their cities more sustainable through a board game. In this game, they took turns to ask each other the questions related to what they've learnt throughout the project, as shown in Figure 6.

Figure 6. The students played sustainability board game with their international peers.

3. Method

3.1. Participants

In this study, a total of 23 students from the same class of fifth graders (10 or 11 year olds) in an elementary school in northern Taiwan were recruited to participate in the intercultural collaborative learning activity. They worked on the intercultural learning project in their regular "Integrative activities" course for two classes a week.

3.2. Experimental procedure and data collection

To assess the effects of the intercultural collaborative inquiry approach on intercultural learning, the 5 Es' inquiry learning activity was conducted in the "Building a sustainable city" project. The purpose of this study was to investigate the students' learning strategies and motivation and their perceptions of collaboration after conducting the intercultural collaborative inquiry approach.

Before the inquiry learning activity, all students filled out the pre-questionnaire of learning strategies, motivation and collaboration. During the intercultural learning activity, the students collaboratively completed their project based on 5E inquiry-based instructional model for three months. Afterwards, all students filled out the post-questionnaires of learning strategies, motivation and collaboration. Finally, one-on-one interview was utilized to probe into students' opinions on the intercultural collaborative learning activity.

3.3. Measuring tools

The questionnaires of learning strategies and motivation and collaboration were applied for assessing the students' awareness of the intercultural collaborative learning activity.

The questionnaires of learning strategies and motivation were designed based on modifying the measurement developed by Lee, Johanson and Tsai, [11]. Their measurement is composed of four dimensions, called deep strategy, deep motive, surface strategy and surface motive. In this study, the questionnaires of learning strategies and motivation were modified from those of the deep motive and deep strategy, respectively. The learning strategies survey consists of eight items using a five-point rating scale, such as "I try to find the relationship between the contents of what I have learned in learning subjects." On the other hand, the learning motivation survey consists of six items with five-point Likert scheme, such as "I feel that intercultural collaborative inquiry can be highly interesting once I get into them."

The collaboration survey was adopted based on modifying the questionnaire developed by Lai, and Hwang, [12]. It comprised five items using five-point Likert item, such as "When I worked with my team members, I think our conversation was good".

4. Experimental result

4.1. Learning strategies

To investigate the influence of the intercultural collaborative inquiry approach on students' learning strategies, a paired sample *t*-test was conducted. As shown in Table 1, a significant difference was found between the two ratings with $t = -2.27$ ($p < 0.05$). The mean and standard deviations of questionnaire of learning strategies are 3.51 and 0.64 for the pre-questionnaire, and 3.83 and 0.65 for the post-questionnaire. Accordingly, it is confirmed that the intercultural collaborative inquiry approach can significantly promote students' deep learning strategies. Furthermore, based on the classification declared by [13], the intercultural collaborative inquiry approach presented a moderate effect size with $d = 0.50$.

Table 1. Paired sample *t*-test for students' learning strategies

		N	Mean	S.D.	*t*	*d*
Learning strategies	pre-questionnaire	23	3.51	0.64	-2.27	0.50
	post-questionnaire	23	3.83	0.65		

$^{*}p < 0.05$

4.2. Learning motivation

To explore the effects of the intercultural collaborative inquiry approach on students' learning motivation, a paired sample *t*-test was calculated. As depicted in Table 2, no significant difference exists between the two ratings with $t = -1.45$ ($p > 0.05$). Moreover, the *t*-test results of the intercultural collaborative inquiry approach gave a small effect size with $d = 0.23$ ($d > 0.20$), implying that this approach had an essentially positive effect on the students' deep learning motivation.

Table 2. Paired sample t-test for students' learning motivation

		N	Mean	S.D.	*t*	*d*
Learning motivation	pre-questionnaire	23	3.77	0.70	-1.45	0.23
	post-questionnaire	23	3.92	0.58		

4.3. Perceptions of collaboration

As regards students' perceptions of collaboration, a paired sample *t*-test was applied to explore the influence that the intercultural collaborative inquiry approach had on the participants. As shown in Table 3, a significant difference (t = -2.14, p < 0.05,) was confirmed between the two ratings with moderate effect size (d > 0.5). The mean values of the students' ratings for the pre-questionnaire and post-questionnaire were 3.71 (*S.D.* = 0.70) and 4.11 (*S.D.* = 0.54), respectively. It was concluded that the intercultural collaborative inquiry approach can significantly enhance students' perceptions of their collaboration competence in the collaborative learning activity.

Table 3. Paired sample t-test for students' Perceptions of Collaboration

		N	Mean	S.D.	*t*	*d*
Collaboration	pre-questionnaire	23	3.71	0.70	-2.14	0.64
	post-questionnaire	23	4.11	0.54		

$^{*}p < 0.05$

5. Discussion and conclusions

In this study, an intercultural collaborative inquiry approach was implemented in an intercultural project. Moreover, an experiment was conducted in the intercultural project for probing into the effects of the proposed approach. The experimental results showed that the intercultural collaborative inquiry approach can significantly promote students' deep learning strategies, as well as their perceptions of collaboration; moreover, this approach can also essentially stimulated students' deep learning motivation.

From the interview results, the students expressed high interests in intercultural collaborative inquiry learning and engaged in the learning activity. It explains that this approach essentially triggered students' deep learning motivation.

As the statement by [4], collaborative learning has been considered to be a strategic tool and a core dimension of interculturality. The intercultural collaborative inquiry approach can significantly enhance students' deep learning strategies and their perceptions of collaboration, implying the significance for intercultural education. It also conforms to what has been reported by [5], who declared that international collaboration can improve students' intercultural competences.

As mentioned above, curriculum integration, and internationalization for intercultural education are lacking in Taiwan [1]. This proposed approach can be utilized to other domain or subject units in the future.

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The role of cognitive styles in collaborative annotations and collaborative performance in CSCL

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Abstract

Research shows that CSCL promote student learning outcome, but very few research explores the role of individual characteristics such as cognitive styles in CSCL environment. Therefore, this study thus attempts to investigate the role of visual/verbal cognitive styles in collaborative annotation and performance in the CSCL environment. 84 junior high students participated in this study. The results indicate that verbal groups have more high-level annotations, and better annotation quality than visual groups in text-based collaborative annotation environment. The results also show a difference in verbal cognitive styles between high and low performance groups, while no difference is found in visual cognitive styles between these two groups. Finally, the results also indicate that collaborative annotations significantly predict CSCL performance.

1. Theoretical background

1.1. Visual and cognitive styles in learning

Research has shown that computer-supported collaborative learning plays an important role in learning [1]. Therefore researchers attempt to explore the factors such as individual characteristics influencing CSCL and performance. Recently, visual and verbal cognitive styles particularly draw much attention in the research of online learning, because online learning environments provide more flexibility and representational format in accord with such individual's styles, which may in turn influences learning. Verbal cognitive style reflects the preference in reading the information content, and the learners with such styles (verbalizers) are theoretically superior in understanding word-based information content [2]. On the other hand, visualizers prefer visual information (e.g., diagrams, pictures, graphs) and usually process pictorial information more effectively [3,4].

Although a study shows no relationship among visual/verbal cognitive styles, material format and learning performance [3], Chen and Sun has shown that visualizer learn best with visual instruction methods, while verbalizers learn best with verbal instruction methods [5]. Mass and Mayer have also suggested that students who prefer visual mode of presentation tend to select pictorial help screens, whereas students preferring verbal mode tend to select verbal help screens [4]. A study on the role of visual/verbal cognitive styles on pictorial-based and text-based searching environment, the results show that student's visual/verbal cognitive style matching to the searching environment lead to higher motivation, and better searching behaviors, which in turn influence their achievement. To date, research has rarely investigated the role of visual/verbal cognitive styles in collaborative behaviors, and performance in CSCL. This study thus attempts to investigate whether students with verbal cognitive styles lead to apply better collaborative annotation behaviors, and collaborative performance than visualizers in the text-based environment.

1.2. Online annotation and performance

Research has shown that online annotation promotes student learning outcome [6]. For example, research suggests that annotation systems in general promote student annotation sharing, elaboration of material, and learning outcomes. In the study of annotation in learning second language, students who use online annotation system in learning have better performance than those who do not [7]. Although research has shown a positive relationship between the quantity of annotations and learning outcomes [6], research has rarely investigated the quality of co-annotation in collaborative performance. A study using video tape observing and text analysis shows the differences in the quality of annotation behaviors among learners [8]. Therefore, this study attempts to explore the quality of annotation behaviors and along its role in collaborative performance in the CSCL environment.

Research questions:

1. What are the differences in online collaborative

annotation and collaborative performance between the groups of visual and verbal cognitive styles in the online text-based collaborative annotation environment?

2. What is the role of online collaborative annotation in students' collaborative performance?

2. Methodology

2.1. Participants

84 junior high students of three classes in "Chinese" course in Taiwan participated in this study. They were taught by the same instructor. These students were divided into 28 groups based on their cognitive style (i.e., visual vs. verbal), and each group consisted of 3 students. Students whose scores of visual cognitive style were higher than their verbal scores were assigned to groups of visual cognitive style, and vice versa.

2.2. Online collaborative annotation system

The online collaborative annotation system (Come2Anno) used in this study was developed by the DCTU-DCSLAB. The Come2Anno consisted of three functions, including annotation (i.e. underline, insert text)(Figure1),collaboration (e.g. discussion, collaborative annotation)(Figure 2), and selection function (e.g. select reading materials). In other words, the system allows students to annotate, to discuss with other members, and synchronous collaboratively annotate with their group members.

Figure 1. The annotation function

Figure 2. The collaboration function

2.3. Questionnaire

The questionnaire of visual/verbal cognitive style was translated from "Style of Processing Scale" developed by Childers, Houston and Heckler (1985). The questionnaire consisted of 20 items, and was reliable with Cronbach's α of .797

2.4. Procedure

Students were asked to fill out the questionnaire first, and then assigned to the groups based on their visual/verbal cognitive scores. Before the experiment, the researchers introduced the use of system, the task and procedure. The task consisted of three short articles: one main article, and two supplemental articles, which were all related to the issues of global warming. The instructor would briefly introduce these short articles for 10 minutes. Students were told to make annotations on the main article using the information of supplemental articles or their own ideas, because latter they could only answer their worksheet by using the main article (including the annotation). During the experiment of the first stage, students had 25 minutes to make annotations individually using the Come2Anno system. At the second stage (collaborative annotation), students could view their group members' individual annotation for 15 minutes, and then they could discuss and annotate collaboratively for 30 minutes through the system. After completing collaborative annotation, students answered the worksheet by using the main article with annotations.

2.5. Content analysis

The content analysis of students' collaborative annotation behaviors was based on Morgan et al. (2008) online annotation behavioral analysis. Students' annotation behaviors were coded as high level processing (original, summary, connection), moderate processing (rephrase), and low level processing (copy). The quality of annotation was estimated by the sum of high (*3), moderate (*2) and low (*1) level of annotations, because these levels of annotation presented different qualities of annotation. The two raters randomly choose two groups to analyze together to achieve the consensus of the content analysis. Then they rated the other 26 groups individually. There were approximately 225 annotations. The inter-rater reliability was over .95.

3. Result

The results of descriptive statistics for collaborative behaviors of verbal and visual groups are shown in Table 1. The results indicate that a total number of annotation behaviors is approximately 225 collaborative annotations.

Table 1. Descriptive analysis of collaborative annotation behaviors (n=28)

Group	N	Collaborative annotation	Max	Min	Mean	SD	Total
Verbal cognitive style	8	high	10.0	2.0	4.50	3.21	36.0
		moderate	5.0	0	1.25	1.75	10.0
		low	9.0	0	5.13	2.90	41.0
		Annotation quality	64.0	15.0	29.50	18.03	236.0
Visual cognitive style	20	high	6.5	0	2.55	1.81	51.0
		moderate	2.5	0	0.68	0.86	13.5
		low	9.0	0	3.68	2.26	73.5
		Annotation quality	33.0	1.0	17.83	9.25	356.5
		Annotations	10.00	0	8.04	2.00	**225.0**

3.1. What are the differences in online collaborative annotations and collaborative performance between the groups of visual and verbal cognitive styles in the online text-based collaborative annotation environment?

The results show that groups with verbal cognitive styles have more high-level annotations and higher annotation quality than those with visual cognitive styles (see Table 2). In other words, verbal groups apply higher level of annotations and better annotation quality than visual groups in text–based collaborative annotation environment. For the differences in collaborative performance, although the results indicate no difference in CSCL performance between the visual and verbal groups, the results show a difference in verbal cognitive styles ($t=2.504$, $p<.05$) between higher and low performance groups.

Table 2. The comparison of collaborative annotation behaviors between verbal and visual groups

	Group	Mean	SD	t	Cohen's d
High Annotation	Verbal (n=8)	4.50	3.20	2.050*	0.86
	Visual (n=20)	2.55	1.81		
Middle Annotation	Verbal (n=8)	1.25	1.75	.886	0.49
	Visual (n=20)	0.67	0.86		
Low Annotation	Verbal (n=8)	5.12	2.90	1.415	0.59
	Visual (n=20)	3.67	2.26		
Annotation quality	Verbal (n=8)	29.50	18.03	2.278*	0.95
	Visual (n=20)	17.82	9.25		

*p<.05, **p<.01, ***p<.001

3.2. What is the role of online collaborative annotations in students' collaborative performance?

The results indicate that the quality of students' online collaborative annotation ($\beta=.468$, $t=2.702$, $p<.05$) significantly predicts their CSCL performance. In other words, groups with better quality of online collaborative annotation have higher CSCL performance.

In sum, the study shows that groups with verbal cognitive styles apply better annotation behaviors, such as high-level annotation as well as better annotation quality. High performance groups also have higher verbal cognitive styles than low performance groups. Groups with better collaborative annotation quality also lead to better CSCL performance.

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Learning Dashboard: Visualization of learning behavior in MOOCs

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Abstract

This study aims to explore the students' learning behaviors in MOOCs by using learning analytics based on Big Data technology. Learning dashboard is the learning analytics which was proposed in Open Edu platform of MOOCs. Based on the Big Data technology, the concept of learning analytic can be implemented more efficiently. This study provides visualization interface for clearly demonstrating the results of learning analytics to give the learning situation of learners to instructors.

1. Introduction

MOOCs (Massive Open Online Course, MOOCs) flips the roles of the instructor and learner during the learning process, thereby developing a learner-centered learning model that further become the part of mainstream academia as the 21st century progresses [1][2][3]. For realizing learner-centered learning model in MOOCs, learners perform self-paced online learning activity through self-viewing lecture videos, discussion with other learners in forums, and doing quizzes or assessments [4]. For facilitating interaction among learners and between learners and the teacher, MOOC platforms provide features such as discussion and feedback forums and virtual labs. These mechanisms aid learners to engage in self-regulated learning [4].

MOOCs has been become popular paradigm in recent years. Owing that there are a large amount of learning data collected in MOOCs platform, the use of learning analytics in MOOC course becomes more necessary. To improve students' learning, learning analytics aims to provide insight about students' learning process to instructors. In recent years, learning analytics has been become an important research field that utilize data analysis to facilitate decisions made for improving learning [5]. With the advancing of Big Data and computer-supported learning technologies, the concept of learning analytic can be implemented more efficiently [6]. Therefore, using Big Data technology to implement learning analytics tools have been attract many researchers attention in the new era of big educational data.

The MOOC platform in Taiwan include of ShareCourse, eWant, Open Edu. Base on the spirit of open and share, Chinese Open Education Consortium (http://copeneduc.org) is developed MOOC platform Open edX (https://www.openedu.tw) to facilitate higher education MOOC Chinese courses. The Open edX platform is developed by edX which is established by Harvard and MIT Universities in 2012, and is a free and open source course management system. The Chinese version of Open edX (https://www.openedu.tw) is developed by Chinese Open Education Consortium in 2015.

2. Learning Analytics in MOOCs

During learning in MOOCs course, students' learning behaviors can be divided into lecture videos viewing, discussion of lecture topic in forums, and self-test of quizzes or assessments. Before MOOCs course online, teachers divide course content into several learning segments. Each learning segment consist of lecture video, unit quiz, and discussion topic in forum. Learners can thereby receive basic knowledge about their learning topics at their own learning pace by viewing online lecture videos with 5 to 10-minute [7][8]. Learners can determine their learning progress by taking a self-quiz before beginning the next learning segment. If learners pass the quiz, they can move to the next unit; that is, they can configure their learning schedule according to their learning pace. For developing learners' critical learning and problem-solving abilities in MOOCs course, the teacher leads learners to in learning practice by quiz unit and group discussion for learning content deeply in forum.

In addition to educate student, we leverage a hosted Chinese version of Open edX platform which installed and configured from the open source edition. The edX is a mass open online course platform developed by team of Harvard and MIT. The open edX consists of short tutorial videos and a learning management system (LMS). The edX LMS offered students to access course video, post issues to discuss with community and recorded behaviour of students. There are two kinds of log can be recorded by edX LMS, the first one is tracking log which recorded students' detail actions interact with edX LMS, such as when to play video, and where to watch video. The second one is MySQL database, which stored course information, such as number of student, and course syllabus.

In Taiwan, Open Edu is a free MOOCs platform for university and institution. OpenEdx Insight is focus on visualizing learning analytics data in OpenEdx platform. Insight can help instructors to monitor students' learning process through visualization demonstration. Therefore, this study enable Insight of Open Edu to help instructors to monitor students' learning. In Open Edu, the insight dashboard includes course enrollment analysis model, course engagement analysis model, performance analysis model, and video interaction analysis model.

3. Big Data Analytic for MOOCs Environment

The recorded log consists of large student behavior information and in line with the characteristics of Big Data, therefore; we designed four steps to enable data analytic for edX environment. To fill the gap between recorded log data and useful information, we introduced four steps to enable Big Data analytic which depicted in Figure 1. It can be divided into: data collection, data storage, information extraction and visualization. From the effort of edX community, the data collection, data storage and information extraction steps can be implemented by edX Pipeline, which is an open source project and fully integrated with analysis tools, such as Apache HDFS, Jenkins and MySQL.

- Data Collection: A log collect engine was implemented by Luigi framework and Jenkins task scheduler. It will fetch the log from edX LMS and MySQL periodically and store it into Apache HDFS after removing unnecessary symbol, such as "@" and "&", in log string. For the reason of highly readable from computer program, the data which stored in Apache HDFS will be translated to JSON format.
- Data Storage: The data which processed by pervious step is sensitive data cause there are more than one personal information, such as students' account ID and physical location, appeared in the datasets. A de-identification process will be executed in this step. In the other hand, not all information is useful for analysis; therefore, a columnisation process will be executed in this step for removing useless string. For example, when the instructor required engagement information, the course syllabus is useless for the measuring.
- Information Extraction and Analytics: After data pre-processing steps, a MapReduce task will load data from Apache HDFS, measure engagement rate for each student and stored consequence into MySQL. The student engagement measurement algorithm will be detailed descript in next section.
- Information Visualization: For exposing the information to instructor, the consequence which stored in MySQL from last step has to be represented by a human readable interface. In this step, we leveraged two edX tools to represent information; the first one is edX API, the second is edX Dashboard. Those tools were interacted with MySQL as a Model-View-Controller (MVC) architecture [9] that allows instructor to read information by Web browser anytime and everywhere.

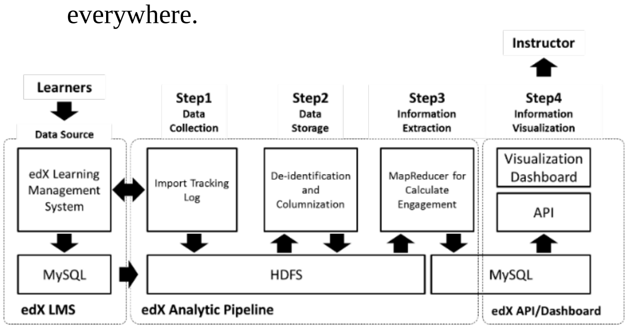

Figure 1. Four Steps to Enable Big Data Analytic in Open edX Environment.

4. Learning Dashboard in MOOCs

In Open Edu, the insight dashboard includes course enrollment analysis model, course engagement analysis model, performance analysis model, and video interaction analysis model. Course enrollment focus on providing the enrollment statistic information of age, gender education level for a specific course. Course engagement aims to analyze the engagement situation over time for each on-learning activity. Course performance provides the statistical analysis of learning performance over time for each student.

4.1. Course enrollment

This study visualize a course named Calculus by using insight dashboard in Open Edu. This course learning was started from 2015/08/01. There are 113 learners have registered this course. The number of enrollments in each day was showed in figure 1. The enrollments gender percentage are 46.4% females and 52.4% males. But there have 1.2% enrollments didn't report their gender. Figure 2 has showed the gender distribution of enrollments. The average age of these enrollments was 23.

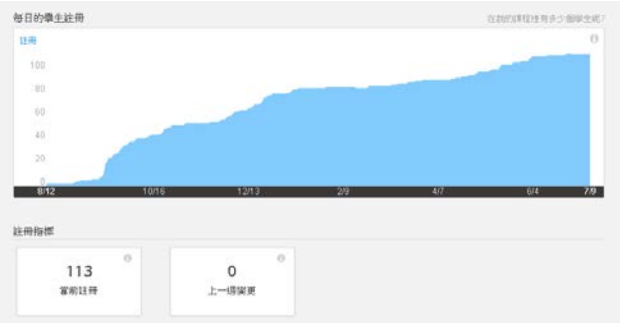

Figure 1. Enrollment number in each day

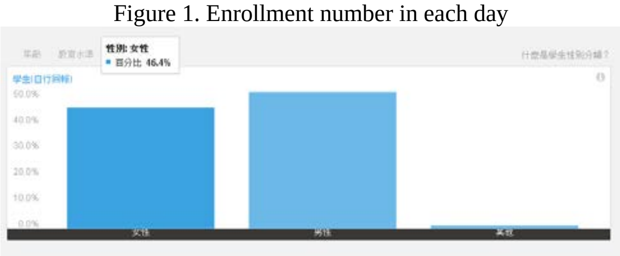

Figure 2. The gender distribution of enrollments

4.2. Course Engagement

Course engagement aims to analyze the engagement situation over time for each on-learning activity. There are four activities record extracted from tracking log stored in Open Edx LMS. The four activities include of play videos activity, attempting problems, reading of posting entries in the forum activity, and other activities in the course website. Figure 3 has showed the number of engaging learners for each learning activity. According to this graph, instructors can understand the total number of the four activities for each week. In figure 3, the number of other activities, play videos, attempting problems, reading of posting entries in the forum were 25, 10, 3, and 0, respectively.

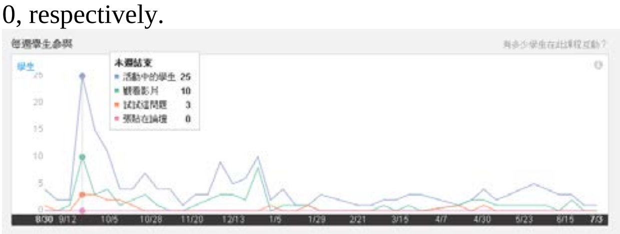

Figure 3. The number of engaging learners for each learning activity

4.3. Course Performance

To understand students' learning performance, the responses situation of quizzes were showed in figure 4. The stepped bar chart in figure 4 represents the number of correct (blue bar) and incorrect (red bar) answers for the problems of quizzes. The percentage of correct and incorrect answers for week 5 were 88% and 12%, respectively. Figure 4 was showed the answer distribution for each quiz.

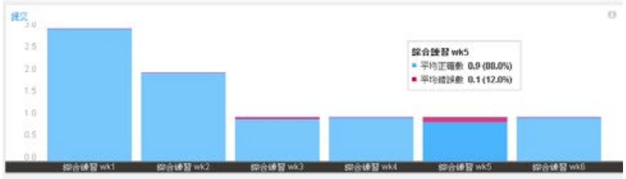

Figure 4. The response situation for each quiz

4.4. Video Interaction

For exploring learners reaction in viewing video, the visualization of video viewing behaviors has attract many researchers attention in recent years [10][11]. Figure 5 has showed the average number of completion viewings and non-completion viewings for each week. Completion viewing represents that learner has viewed the video end. Otherwise, learner didn't view the video end indicates non-completion viewing. The green areas and grey areas in figure 5 are indicate the number of completion viewings and non-completion viewings, respectively.

Figure 5. The average number of completion viewing and non-completion viewing for each week

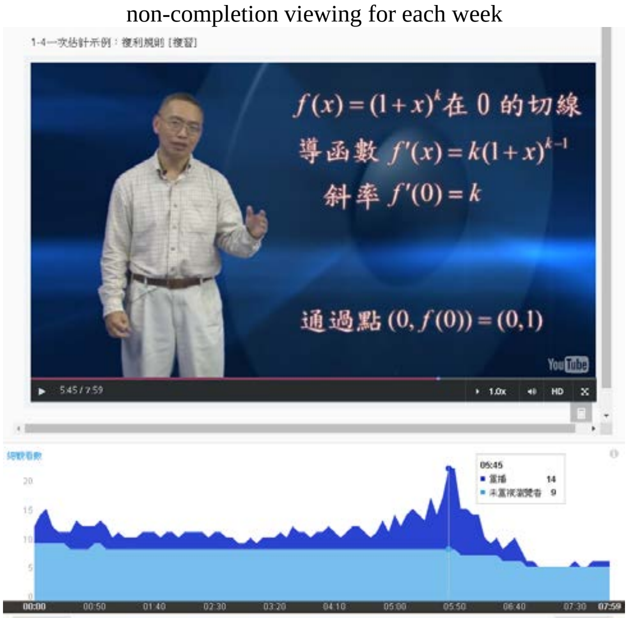

Figure 6. The number of repeat viewings and non-repeat viewings over time

In the figure 6, the specific video of learning unit 1-4 can be previewed in top area, and the number of repeat viewings and non-repeat viewings are showed in the bottom area. The x-axis represents continuity time for this video, and the y-axis indicates the viewing number of this video at the specific time. The blue area and water blue in the bottom area of figure 6 indicate the number of repeat viewings and non-repeat viewings, respectively. For observing figure 6, it has the viewing peak during the period from 5:45 to 5:55. In the peak at the time 5:45, the number of repeat viewings and non-repeat viewings were 14 and 9, respectively. To investigate the cause of this viewing peak, we previewed the video content at 5:45. This video content was to introduce the concept of derived function. At the video time 5:45, the instructor explained the inference process for derived function. This is the cause of this viewing peak. From above description, instructors can get learners' viewing reaction information according to the visualization of viewing behaviors. For promoting learners' comprehend of learning content, instructors can improve the video content according to the learners' viewing behaviors.

5. Conclusions

Learning analytics is an effectively approach to understand learners' behaviors by using big data technology to mining learners' behaviors from the huge number of learning records which were stored in on line course platforms. This study explores learners' learning behavior in a MOOC course named as Calculus in Open Edu. The learning patterns retracted by learning analytics can help instructors give timely learning suggestions to learners. Furthermore, the objective of adaptive learning and teaching can be realizing.

This study has proposed the learning analytics mechanism based on Big Data technology. The proposed learning analytics mechanism includes "Data Collection", "Data Storage", "Information Extraction and Analytics", and "Information Visualization" steps. The learning analytics model includes enrollment model, engagement model, performance model, and video interaction model. For realizing adaptive learning and teaching, this study provides visualization interface for clearly demonstrating the results of learning analytics to give the learning situation of learners to instructors. The visualization of learning analytics is aim to demonstrate students learning behaviors to instructors. The instructors then can give timely learning suggestions to learners according to the results of learning analytics.

6. Acknowledgements

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Development of a game-based learning system based on the concept-effect model for improving mathematic learning achievements

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Abstract

Mathematics education is known to be challenging for both teachers and students. Due to a lack of interesting learning scenarios and proper learning support, students often feel bored and frustrated in the mathematics learning process and are not interested enough to learn more. The concept-effect model is an effective tool for the organization of learning material in developing diagnostic systems for detecting students' learning problems. In this study, an interactive game-based learning system is proposed to improve students' fraction learning achievement based on the concept-effect relationship model. An experiment was conducted on an elementary school mathematics course to evaluate the effects of the proposed approach. The experimental results show that the approach can not only improve the students' achievements, but can also enhance their learning attitudes in mathematics courses.

Keywords: *concept-effect relationship, game-based learning, mathematics, fractions.*

1. Introduction

In the past decades, several studies have indicated that students face difficulties in learning mathematics, especially elementary school students, who struggle with abstract and complex mathematics concepts such as fractions [1, 9]. Although formulas taught by teachers could prompt students to solve math questions, researchers have indicated that this learning approach might not be sufficient to recognize the process of solving the questions for students [3]. Moreover, it is difficult to attract students to learn boring formulas and correctly apply the math concepts to different problems [6]. Hence, it is important to consider not only increasing students' learning interest and attitudes, but also enhancing students' understanding of complex relationships among concepts while developing their mathematics learning.

With the rapid advancement of technological instruction, one of the well-studied strategies in teaching instruction and learning guidance, the concept-effect relationship (CER), has been proposed and has been widely applied in the domain of education diagnosis models [2, 11]. Structured learning guidance is regarded as an effective approach which promotes deeper understanding in conceptual-knowledge learning, especially for students who have difficulty with the learning material [4, 8].

On the other hand, in order to enhance students' active engagement in learning activities, several studies have reported that game-based learning has benefits in terms of stimulating students' learning engagement and higher order thinking. Furthermore, many game-based learning systems have been applied to various educational applications. For example, researchers have noted the importance of the game-based learning approach as an effective technology-enhanced learning approach in language learning [10, 12]. Callaghan et al. [7] reported the positive effect of simulation games on students' learning motivation in electronic and electrical engineering courses. However, researchers have also indicated that without properly incorporating learning supports or strategies, the effectiveness of the game-based learning approach could be limited, especially for the comprehension of mathematical concepts [6]. Hence, the development of an effective instructional approach for supporting game-based learning activities has become an important and challenging topic.

To cope with this problem, in this study, a game-based learning system based on the concept-effect relationship approach was developed for conducting mathematics learning activities. Furthermore, an experiment was conducted in the fraction unit of an elementary school mathematics course to evaluate the effectiveness of the proposed approach in terms of the students' learning achievement and learning attitudes.

2. Development of a CER-based mathematics game

In this study, we present a concept-effect relationship (CER) for fractions to assist teachers in grasping students' learning status, and to provide adaptive learning guidance during the gaming learning process. Furthermore, this game incorporates concept-effect relationship learning strategies into the gaming scenarios to assist students in improving their learning attitudes and performance. Figure 1 represents the structure of the CER math game, which consists of the gaming module, the concept-effect relationship module, the learning behavior module, and the learning guidance module. The gaming module provides a scenario that includes scripts, materials, and problem-solving contexts for students. The concept-effect relationship module is in charge of defining the knowledge levels of each learning concept and relationship among the concepts through teachers. Moreover, this module could identify the poorly learned concepts for individual students by analyzing their learning portfolios. Next, the learning behavior module enables teachers to observe students engaged in tasks and their learning status based on the obtained results of CER. Lastly, the learning guidance module is used to select appropriate learning material. This module enables students to grasp unfamiliar or poorly understood concepts more quickly, and helps them with concept consolidation and elaboration.

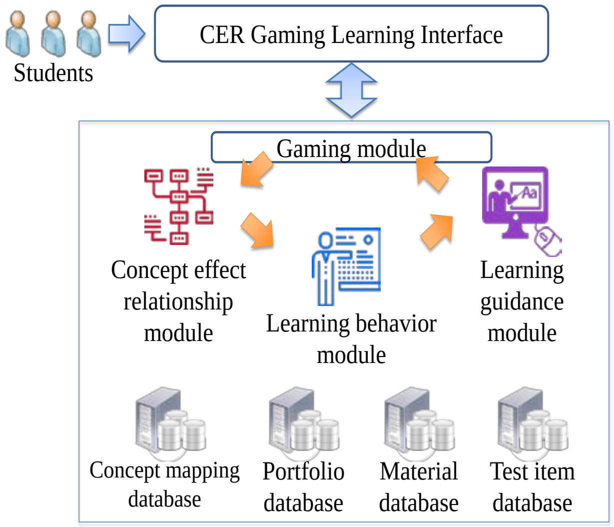

Figure 1. The structure of the proposed game

Figure 2 illustrates the gaming scenario of triggering the selected learning task. In this game, students (playing the role of the main character) are asked to find all of the treasures and complete tasks to pass each challenge; that is, the storyline provides students with an opportunity to accumulate knowledge of relevant fraction practices during the gaming process. The accumulated knowledge is recorded in the portfolio database for further learning behavior analysis.

After completing the collected treasures and tasks, an adaptive game process is customized by analyzing the students' learning behavior to generate learning guidance for individual students. Moreover, this way provides students with an engaging way to select appropriate learning material (as shown in Figure 3).

3. Experimental Design

To evaluate the effectiveness of the proposed CER mathematics game in this study, a quasi-experimental design was conducted for the fraction unit of an elementary school mathematics course. Moreover, this study aimed to investigate the effects of the proposed CER learning approach on the students' learning achievement, attributes, and learning attitudes.

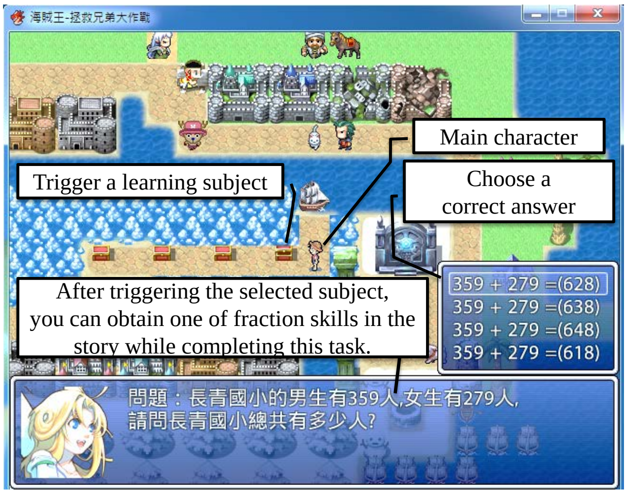

Figure 2. Gaming scenario of triggering the fraction task

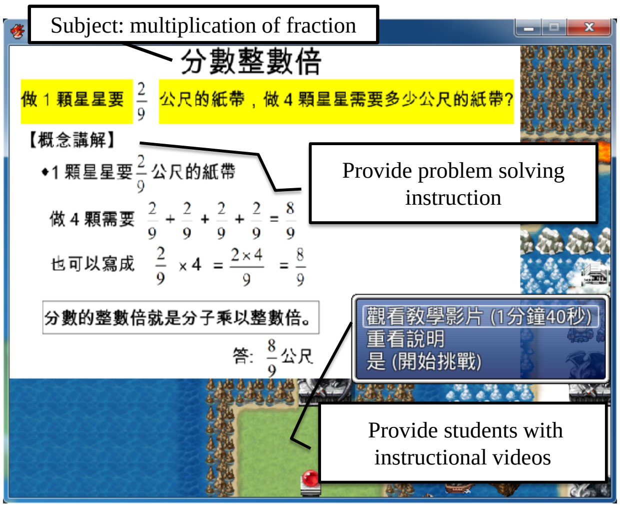

Figure 3. Illustrative example of learning guidance

3.1. Participants

The participants of this study were 56 third grade students in two classes of an elementary school in northern Taiwan. Each class consisted of 28 students. A quasi-experiment was designed by assigning the students in one class to the experimental group, and the other class to the control group. The experimental group learned with the concept-effect relationship map embedded game learning, while the control group learned with the conventional digital game without the concept-effect relationship. All of the students were taught by the same teacher who had more than ten years' experience of teaching mathematics courses.

3.2. Measuring tools

In this study, the measuring tools included a pre-test, a post-test, and the questionnaire for measuring the students' learning achievements and attitudes. The pre-test aimed to identify any differences in the students' prior knowledge of learning the course unit. It consisted of eight mathematics word problems, giving a perfect score of 100. The post-test consisted of four matching problems and twenty mathematics word problems for assessing the students' knowledge of the fraction unit in mathematics. The perfect score of the post-test was 100.

The questionnaire of learning attitude was modified from the measure developed by Wang, Chu and Hwang [5]. It contains 7 items using a 5-point Likert scale rating scheme. The Cronbach's alpha value of the questionnaire was 0.91.

3.3. Experiment procedures

Figure 4 shows the procedure of the experiment. Before the learning activity, the two groups of students took a week-long course on the basic knowledge of fractions, which is part of the mathematics course in the selected school.

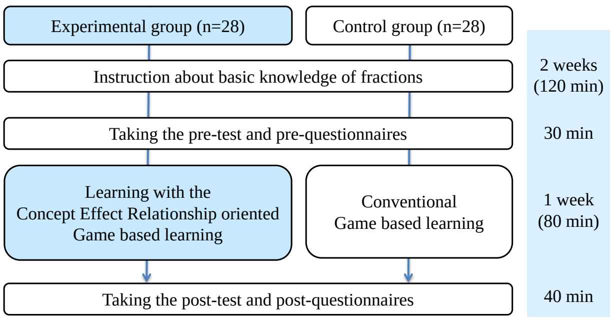

Figure 4. Experiment procedure

At the beginning of the learning activity, the students took the pre-test and completed the learning attitude questionnaire. During the learning activity, the students in the experimental group learned with the concept-effect relationship-embedded computer game; on the other hand, the students in the control group learned with the conventional digital educational game without any concept-effect relationship guidance. The students in both groups were scheduled to learn by playing the educational digital games and to complete all learning tasks based on the same gaming scenarios, learning missions and learning content.

After completing the game-based learning activity, the students took the post-test and the learning attitude questionnaire for comparing the learning achievements and the improvements in learning attitude of the two groups.

4. Experimental Results

4.1. Analysis of learning achievement

Examining the effectiveness of the proposed CER-based math game, the results show that the mean values and standard deviations of the pre-test scores were 77 and 12.25 for the control group, and 72.57 and 17.82 for the experimental group (as shown in Table 1). Here, the t-test result (t = -1.08, p > .05) reveals that the control and experimental groups were not significant. In other words, before performing the experiment, it is evident that the two groups of students had equivalent prior knowledge.

Table 1. *t*-test result of the pre-test scores

	Group	N	Mean	S.D.	t
Pre-test	Experimental Group	28	72.57	17.82	-1.08
	Control Group	28	77	12.25	

After the learning activity, a one-way independent-samples analysis of covariance (ANCOVA) was used to examine the difference between the two groups. Moreover, this analysis used the pre-test scores as the covariate and the post-test scores of learning achievement as dependent variables, as shown in Table 2. The adjusted mean value and standard error of the post-test scores were 74.07 and 2.12 for the control group, and 82.79 and 2.12 for the experimental group. According to the results (F = 8.378, p < .01), there was a significant difference between the two groups, implying that the students who learned with the CER-based math game showed significantly better learning achievements than those who learned with the game without the concept-effect relationship (CER) approach.

Table 2. ANCOVA results of the post-test scores

Group	N	Mean	S.D.	Adjust mean	Std. error	F
Experimental Group	28	82.04	10.65	82.79	2.12	8.38^{**}
Control Group	28	74.82	13.58	74.07	2.12	

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

4.2. Analysis of learning attitudes

Table 3 shows the t-test result of the students' learning attitudes. According to the results (t=-5.39, p<0.001), it was found that the learning attitudes of the students in the experimental group significantly improved after the learning activity. On the other hand, the control group students' attitudes showed no significant improvement. Consequently, it can be seen that the CER-based mathematics game not only improved the students' learning achievements, but also enhanced their learning attitudes.

Table 3. *t*-test result of the students' learning attitudes

Group		Mean	S.D.	t
Experimental Group (n=28)	Before	3.87	0.22	-5.39***
	After	4.38	0.10	
Control Group (n=28)	Before	3.79	1.68	-2.02
	After	3.93	0.97	

***$p < .001$.

5. Conclusions and future work

In this study, a concept-effect relationship-based digital game was developed for conducting mathematics learning activities. An experiment was conducted in a mathematics fraction learning activity to evaluate the performance of the proposed approach. The experimental results demonstrated that, in comparison with the concept-effect relationship approach with conventional game-based learning, the proposed approach significantly improved the students' learning achievements and attitudes. Currently, it is a time-consuming process for teachers to prepare proper contexts without support; therefore, it is important to develop supporting tools for teachers. Meanwhile, to avoid giving inaccurate suggestions or advice to students, further research is needed to investigate the effect of the co-operation of multiple experts. It is hoped that this approach can be applied to various practical applications.

In the near future, we will apply a cooperative learning strategy, Team Assisted Individualization (TAI), to investigate the effectiveness of group learning support in mathematics. It is expected that such a setting will enable students who are lagging behind in mathematics to catch up with their peers.

7. Acknowledgements

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Intervention Effects of a Computerized Collaborative Scaffolding System on Students' Problem-solving Competency

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Abstract

The purpose of this study is to develop a dynamic assessment system on computerized problem-solving (DASOCPS) for 6th to 9th grade students. Based upon six cognitive components of item difficulty and strategies of metacognition, the scaffold of collaborative tasks for promoting students' problem-solving ability and metacognitive awareness was developed. A total of 104 8th graders were assigned into experimental and control group for investigating the intervention effects of DASOCPS. The growth slopes analysis reveals that the intervention effects of DASOCPS are significant on problem-solving ability and metacognitive awareness. To sum up the study, these two important variables could be improved by effective intervention. Therefore, the DASOCPS developed in the study can serve as valid resource for research or instruction of problem-solving ability and the metacognitive awareness involved. The scaffold framework of DASOCPS is especially valuable for problem-solving embedded curriculum development.

Keywords: *problem-solving ability, metacognitive awareness, cognitive component, dynamic assessment, collaborative intervention tasks*

1. Introduction

Problem-solving competency has been viewed as one of the fundamental skills in the twenty-first century [1] [2][3]. Therefore, educators and policy makers are especially concerned about students' competencies of applying useful information derived from interaction with the environments to solve problems in real-life settings[2][4][5][6]. Meta-cognition is an important aspect of problem-solving because it includes problem-relevant awareness of one's thinking, monitoring of cognitive processes and regulation of cognitive processes and application of heuristics [5] [7] [8]. Research findings suggest that teachers need to devise strategies such as meta-cognitive strategy instruction to help students acquire and develop knowledge and regulation of cognition so that they can become effective problem solvers [5] [8]. In this study, for the purpose of improving the performance of these two related competencies, computerized dynamic assessment (CDA) was applied for being as the scaffolding system. Dynamic assessment is an interactive procedure that systematically and objectively measures the degree of change that occurs in response to cues, prompts, strategies, feedback, or task conditions that are introduced during testing. On the other hand, dynamic assessment also integrates instruction into a seamless and ongoing activity [9] [10] [11] [12]. With the advantages of integrating instruction and embedded prompts, the intervention of dynamic assessment is flexible to design for demand that researchers recommend on promoting problem-solving ability and meta-cognitive awareness, such as providing explicit instruction in both cognitive knowledge and cognitive regulation, using collaborative or cooperative learning methods, using tasks and activities that make student conceptions and beliefs visible, promoting awareness of metacognition [12] [13]. A computerized collaborative scaffolding system was developed in this study for the following two reasons. First, providing metacognitive support for young adolescents is useful in problem-solving and the support provided during the solution process is significantly more effective than only at the end of process [14] [15]. Second, collaborative tasks is important for problem-solving and meta-cognitive awareness because individuals need to be able to interact effectively with others or environment for relevant information and then joint use of different resources and agreement on strategies and solutions in an increasingly networked and interdependent world [2] [6] [16] [17]. Taking two demands mentioned above into account, computerized dynamic assessment is appropriate to be as the tool for scaffolding.

Based on the described above, the main goal of this study is to develop the computerized dynamic assessment system and investigate the intervention effects on participants' problem-solving ability and metacognitive awareness.

2. Method

2.1. Participants and procedures

A total of 104 8th graders were sampled in this study. 50 students were assigned into experimental group, and 54 students were assigned into control group. The proportion of the sample by grade and gender are nearly the same. Multi-assessments includes computerized problem- solving assessment (CPSA) and computerized problem- solving meta-cognitive awareness assessment (CPSMA) for measuring modifiability with the intervention of Dynamic Assessment System on Computerized Problem-Solving (DASOCPS).

Table 1. Sample distributions for the different groups

Assessment	Form			Total
	A	B	C	
Multi-assessments of DASOCPS	Experimental group		Control group	
	50		54	104

2.2. Dynamic Assessment System on Computerized Problem-Solving (DASOCPS)

In the intervention of DASOCPS, two stages adopted to form the framework of the intervention (see Figure 1) in the computerized dynamic assessment are as follows: choosing strategies and applying strategies (see Figure 2 and Figure 3). Each problem is including the two stages. There are total four problems designed in the intervention and each problem has two stages scaffold for students. Students can't manipulate the interactive surface in stage 1 but they can obtain information about how the dynamic interaction works by observing the demonstration of the movie clip in operation area. After realizing the context of problem and how interactive operation works, students have to evaluate the effectiveness of four strategies provided. Meanwhile, the movie clips of strategies are also provided to assist students in more comprehending the strategies except the description of words. Each Student of each group would complete individual worksheet first. Then group members would discuss the evaluation score of strategies and the reason why they make the decision. Finally the group members would collaboratively complete the group worksheet. Basically, the teacher controlled the process and plays the role of a facilitator who instructed and guided the students to accomplish the tasks and group discussion step by step.

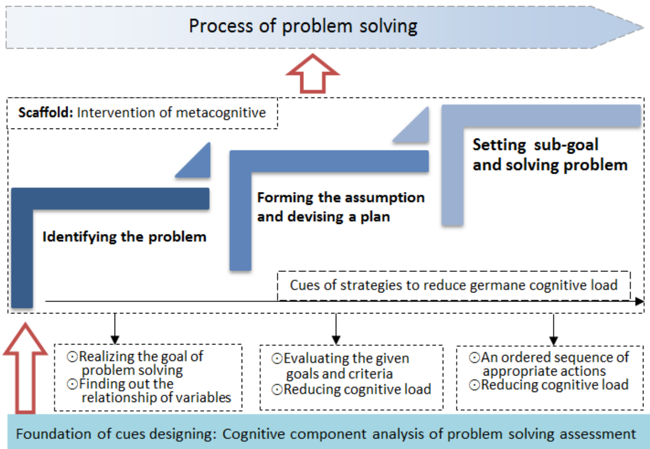

Figure 1. Scaffold framework of DASOCPS

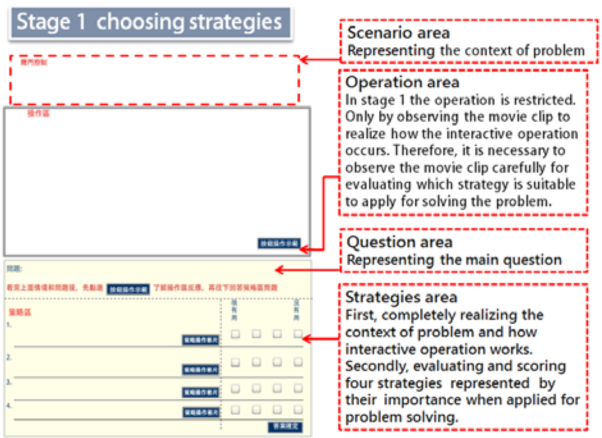

Figure 2. Stage one of intervention

Accordingly, the teacher would host the group discussion that each group stated and clarified their conclusion and explained the reason. By means of discussion within group to among groups, student would obtain information and therefore scaffold was formed to support them to comprehend the relation between the problem and strategies. Stage two of intervention in DASOCPS is applying strategies. The interface is similar to stage one such as scenario area and question area. However, the operation area is different because in stage two the interactive operation is allowed. Furthermore, students can apply and verify the strategies discussed collaboratively in stage one by trying the interactive operation. In instant response, students can observe the appropriateness of strategies and revise them if the solution is incorrect. Another different area is prompts area that prompts are provided based on cognitive components of problem-solving (Lee, Hung, & Chang, 2016) for reducing cognitive load only if students have difficulty finding the answer can they search for support from prompts area.

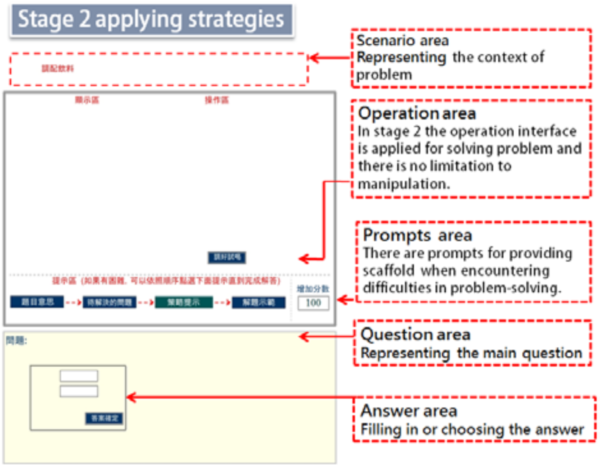

Figure 3. Stage two of intervention

3. Result

3.1. Contrasts on growth slope of problem-solving ability

To investigate the effect of intervention in **DASOCPS,** the Hierarchical Linear Model (HLM) was used to describe the progress of problem-solving ability and meta-cognitive awareness respectively. HLM has the advantage of analyzing longitudinal data retrieved many times. Therefore, HLM was used to analyze the students' scores of problem-solving ability and meta-cognitive awareness from three different time points. Table 2 shows the analysis results of coefficients estimated by unconditional model and intervention effect model of HLM on problem-solving ability. The unconditional model results indicate that the average growth rate, slope (γ_{10}), of all participants is around 0.24 (p<.01), and t is 3.08(p<.01).This suggests that growth rate is different between two groups. Therefore, further analysis used is intervention effect model to investigate the difference of growth rate. Slope γ_{10} (-0.07) and γ_{11}(0.63) show that effect of intervention is evident in experimental group. Figure 4 shows the comparison of growth slope of intervention effect model between two groups on problem-solving ability. The first interval between one and two point is six weeks and the second interval between two and three time point is three weeks. Furthermore, the difference of growth rate according to the coefficient from table 2 between two groups is more easily observed. Accordingly, the experimental group demonstrated substantial growth compared to control group in problem-solving ability.

Table 2. Comparison of two models' growth slope on problem-solving ability

Fixed Effect	Model 1 (unconditional)				Model 2 (intervention effect)			
	Coe.	*SE*	*t*	*p*	Coe.	*SE*	*t*	*p*
INTRCPT (γ_{00})	-0.63	0.11			-0.62	0.15		
γ_{01}					-0.04	0.21	-0.12	0.87
Slope (γ_{10})	0.24	0.08	3.08	0.00	-0.07	0.10	-0.71	0.48
γ_{11}					0.63	0.14	4.51	0.00

Table 3. Comparison of two models' growth slope on metacognitive awareness

Fixed Effect	Model 1 (unconditional)				Model 2 (intervention effect)			
	Coe.	*SE*	*t*	*p*	Coe.	*SE*	*t*	*p*
INTRCPT (γ_{00})	-0.43	0.03			-0.43	0.05		
γ_{01}					-0.00	0.07	-0.01	0.99
Slope (γ_{10})	0.15	0.04	4.06	0.00	-0.05	0.04	-1.19	0.24
γ_{11}					0.42	0.06	6.65	0.00

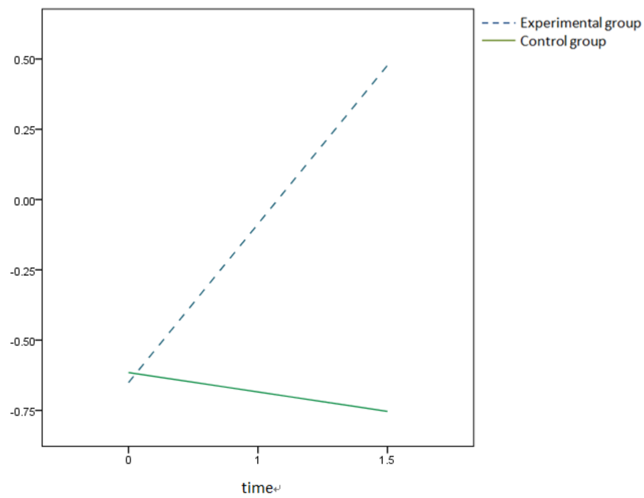

Figure 4. Comparison of growth slope of problem-solving ability between experimental and control groups on intervention effect model

3.2. Contrasts on growth slope of meta-cognitive awareness

Table 3 shows the analysis results of coefficients estimated by unconditional model and intervention effect model of HLM on meta-cognitive awareness. The unconditional model results indicate that the average growth rate, Slope (γ_{10}), of all participants is around 0.15 (p<.01), and t is 4.06 (p<.01).This suggests that growth rate is different between two groups. Therefore, further analysis used is intervention effect model to investigate the difference of growth rate. slope γ_{10} (-0.05) and γ_{11}(0.42) show that effect of intervention is evident in experimental group. Figure 3 shows the comparison of growth slope of intervention effect model between two groups on meta-cognitive awareness. The difference of growth rate according to the coefficient from table 3 between two groups is more easily observed through figure 5. Accordingly, the experimental group demonstrated substantial growth compared to control group in meta-cognitive awareness.

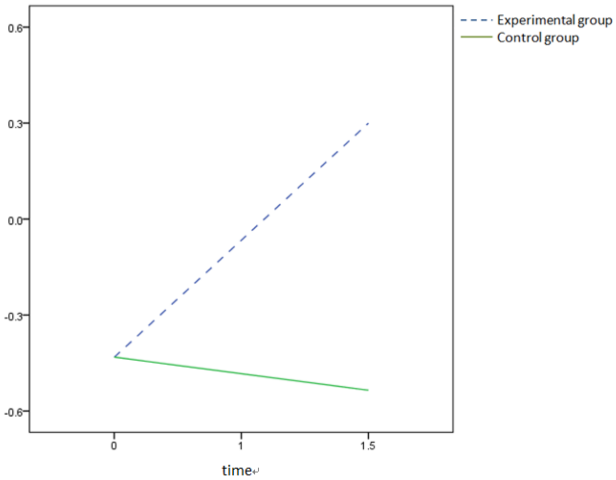

Figure 5. Comparison of growth slope of metacognitive awareness between experimental and control groups on intervention effect model

4. Conclusion

The results presented in this paper indicate that the proposed computer-based dynamic assessment (CDA) is evidently effective to be as the scaffolding system. Since the data collected show that the intervention of CDA system has benefit in improving problem-solving ability and meta-cognitive awareness of 8th graders. The experimental group students who accepted intervention of CDA demonstrated more substantial growth than control group on performance of CPSA and CPSMA. The analysis of the results imply that scaffolding system can serve as valid resource for research or instruction of problem-solving ability and the metacognitive awareness involved.

Acknowledgements

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Development and evaluation of a problem-based ubiquitous learning system based on a collaborative competency scoring rubric

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Abstract

The purpose of this study is to investigate the progress of students' collaborative competency in field inquiry activities. A total of 70 sixth and fifth graders were recruited to participate in a field observation activity with the support from a ubiquitous learning system. Moreover, a rubric was developed and validated for assessing the students' collaborative competency. The participants' on-line discussion records were analized to investigate the performance and progress characteristics of collaborative inquiry learning. The experimental results show that the students' collaborative competency was significantly improved after the learning intervention. Moreover, the reasonable correlation coefficient pattern among collaboration competency, scientific inquiry ability and school academic performance provide substantial evidences to validate the developed rubric. The scoring rubric and its corresponsing scoring samples are valuable resources for further research and practice of collaborative problem-solving learning design.

Keywords: *ubiquitous learning, problem-based learning, collaborative learning competency, scoring rubric*

1. Introduction

In the past decades, collaborative learning has been seen as an effective teaching method and learning strategy [4]. Various collaborative learning techniques and instructional skills have been developed and applied in different learning situations, such as Jigsaw II [13] and Learning Together, for fostering learning and elaborating teaching [1]. Among various frequent applications of collaborative learning, science inquiry is such an activity that has been defined as a process of identifying and posing questions, searching for information, designing and carrying out scientific investigations, analyzing data and making conclusions, creating artifacts, and sharing and communicating findings [2] [15]. This learner-centered learning method emphasizes the application of classroom-learned knowledge to realistic scenes as well as the importance of concern for personal living surroundings and exploring novel and meaningful questions for practical use or thorough understanding. Following the recent rapid advancements in information technology, computer supported collaborative learning (CSCL) has become a potential direction for scaffolding students' critical thinking and problem-solving competences [6]. Many researchers have identified the potential of using computer systems to support collaborative learning activities [3] [14]. For example, several studies have employed the computer-supported collaborative learning (CSCL) approach to conducting problem based learning (PBL) activities [12], in which students can develop their collaborative learning skills through the activities of problem exploration, peer discussion, and problem solving in the process of PBL with the assistance of technological tools [13]. Problem-based learning, which focuses on spontaneity, collaboration, and flexible problem-solving skills, is such an approach that engages students in problem-solving scenarios. In the past decades, PBL has become increasingly popular in settings from K-12 to undergraduate education [1]. During the problem solving process, students construct domain knowledge and develop both problem-solving skills and self-directed learning skills while working toward a solution to a problem. A number of researchers have confirmed the benefits and effectiveness of PBL [2][8]. Contrasted with the advantages of applying technology, there are still four challenges faced in the implementation of contemporary science CSCL environments, namely (1) most applications do not seem to be robust enough to support social interaction, quick feedback and evaluation across distances and at different times; (2) few applications are available to support synchronous collaboration; (3) with their flexibility limitations, most of these environments are not appropriate for a wide range of activities in different science subject areas; and (4) most systems are not comprehensive enough to combine inquiry, modeling and collaborative learning approaches to facilitate students' development of critical learning skills in science

[15].

An innovative pedagogical method, which is defined as ubiquitous problem-based learning (UPBL), has been confirmed as a potential and productive learning approach [8]. Furthermore, the use of mobile technologies has also become more popular for collaborative science inquiry because of the advantages of portability and information retrieval which can occur at any time and in any place [5] [3] [9]. In the meantime, researchers have emphasized the importance of situating students in authentic learning environments [11], and have indicated the potential of using mobile, wireless communication and sensing technologies (such as QR-codes or Global Positioning Systems) in providing learning supports to students in real-world explorations [10]. That is, without being constrained by physical space and time, the impacts of PBL can be strengthened in ubiquitous learning contexts.

Along these lines, the purpose of this present study is to build up a ubiquitous learning platform for students, and investigate the effect of promoting collaborative learning competency in the problem-based scientific inquiry activities with the scoring feedbacks for their online discussions. The scoring rubric developed in this study played an important role of guiding and encouraging the students to collaborate with group members for working on UPBL task and accomplishing the science inquiry report. Accordingly, the following research questions are investigated:

(1)Do the rubrics developed to assess collaborative learning competency demonstrate reasonable validity?

(2)What is the correlation coefficient pattern of collaborative learning competency, science inquiry ability and academic performance?

(3)What is the characteristics of students' collaborative learning progress?

2. Method

2.1. Participants and procedures

A total of seventy 5th and 6th graders from three different schools participated in the UPBL program. Thirty four of them were male and the other 36 were female. The students were randomly assigned into different groups.

2.2. The Ubiquitous Problem-based Learning System (UPBLS)

The section of group task is the central working area in UPBLS. It provides the basic function for editing the notes, diaries, and reports. Besides the central group task area, UPBLS provides three other functions: On-line discussion for community collaboration, On-line statistics for measurement and statistics sharing, and E-library for ecology knowledge clarification. The interfaces of these three functions are provided in Figures 2. UPBLS is developed to optimize the collaboration for the inquiry community. With these functions, each group of students was guided to accomplish their group task. On-line discussion is designed to help students reflect, clarify, stimulate, and monitor their inquiries. E-library contains an ecology database. The students can search for information when describing and recording the findings about the creatures of the ecology environment. Furthermore, measurement statistics is provided in the "On-line statistics" of UPBLS for presenting the collected data, such as salinity, ph value, dissolved Oxygen of water, turbidity and temperature in three different areas. The participants can search for the information they need in this "On-line statistics" and utilize these data in their group reports. The UPBLS works as both a learning tool and a collaborating tool. With the assistance of UPBLS' functions, students can more easily to collaboratively work on their problems, planning, execution and reflection, and accomplishing the report.

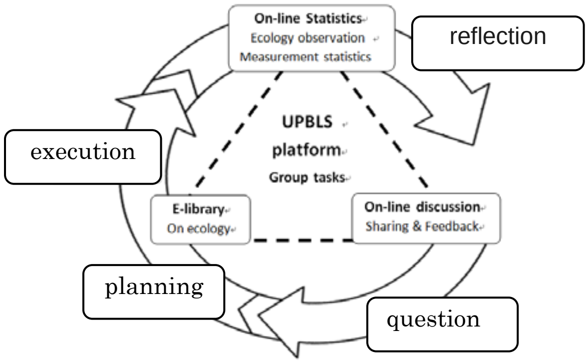

Figure 1. A triangle model for UPBLS design.

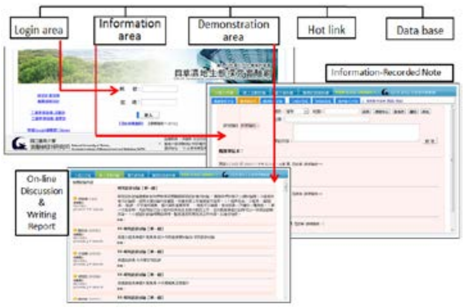

Figure 2. Three main functions of Ubiquitous Problem-Based Learning system (UPBLS)

2.3. Computerized Scientific Inquiry Literacy Assessment (CSILA)

In this study, the Computerized Scientific Inquiry Literacy Assessment (CSILA), developed by Hung, Hwang, Lin, Hung and Wu (2010), was adopted as a criterion variable. The facets included in CSILA are observation, inference and experiment design. There are three different item types: observation of photos, movie clips and concept mapping. Each facet was divided into three levels: basic, proficient, and advanced. The average difficulty (p value) of the items is 0.62 and the

Cronbach's α of the measure is 0.71.

2.4. Scoring rubrics for collaborative learning competency- example of reflection

Three aspects of participants' collaborative learning competency were rated based upon the rubrics developed in this study. These three aspects are searching for relevant information, technology application and reflection for collaborative learning. The scoring rubrics for reflection are provided as an example in table 1.

Table 1. Scoring rubrics for reflection of collaborative learning

Score	Description	Example
1	1. Unable to understand the benefit and basic way of collaboration 2. Unable to reflect on how to contribute to the team work	★Research title: The growing environment of Fiddler crab It's strange to cooperate with someone I don't know because I don't know how he looks like. However, I can talk quite freely in this situation.
2	1. Be able to understand the benefit and basic way of collaboration 2 .Unable to reflect on how to contribute to the team work	★Research title: The growing environment of Black-faced Spoonbill ◎For general collaboration performance: It's not good because someone did not cooperate and ruin the working climate. ◎Suggestion for next discussion: I hope everyone can cooperate with others and communicate well. ◎For personal contribution: Almost nothing, I was dreaming all the time. ◎Who performed the best in the group: Tong, because she did everything. ◎Who performed the worst in the group: Yu, because he can't be cooperative.
3	1. Be able to understand the benefit and basic way of collaboration 2. Be able to reflect on how to contribute to the team work	★Research title: The growing environment of Mangrove ◎For general collaboration performance: It's not very good because everyone had different opinions. ◎Suggestion for next discussion: I'll try to persuade others to accept my own thought. ◎For personal contribution: I provided the descriptions of the similarities and differences between Kandelia and Rhizophora stylosa ◎Who performed the best in the group: Yo, because he proposed a lot of creative ideas. ◎Who performed the worst in the group: Shaun, because she didn't talk at all.

3. Result

3.1. Reliability and validity of the scoring rubrics

The first section of analysis focuses on the evidences of reliability and validity of the rubrics developed for assessing collaborative learning competency. In the study, performance on CSILA is defined as the one of the related variables for validation of the scoring rubrics of collaborative learning competency. The result of rating by different raters basing upon the rubrics shows that the scorer reliability ($r=.89$ to $r=.91$, $p<.01$) is high. On the other hand, the significant correlation coefficients between collaborative learning competency and related variables were shown in table 2. The correlation coefficients demonstrate reasonable convergent and discriminant validity pattern. The correlation between scientific inquiry ability and collaborative learning competency got stronger when the participants became more experienced in field inquiry.

Table 2. Correlation coefficient matrix of collaborative learning competency, scientific inquiry ability and academic performance

	Scientific inquiry	Chinese	Math	Science	Social science
Collaborative Learning competency	.67~.73	.52	.51	.58	.44

3.2. The participants' growth slope on collaborative learning competency

The second section analysis focuses on the progress of students' collaborative learning competency based on their discussion ratings. The descriptive statistics of collaborative learning competency for three different activities were provided in 3 to demonstrate students' learning progress trend. With the support of the learning system, students were becoming better collaborative learners.

To analyze the results formally, the Hierarchical Linear Model (HLM) was adopted to analyze the students' scores of collaborative learning competency from three different time points. Table 3 shows the analysis result of coefficients estimated by the unconditional models of HLM. The unconditional model results indicate that the average growth rate $\beta 10$ of all participants is around .46 ($p<.01$). This suggests that the participants demonstrated substantial growth in their collaborative learning competency. Generally speaking, the result reveals that UPBLS is significantly helpful for developing students' collaborative inquiry performance. Variations of slops were also found among different groups. One major difference was found on their progressions of reflection. The more efficient learning groups (high slope) demonstrated larger progress on their reflection of collaborative learning than the less efficient groups (low slope).

Table 3. The descriptive statistics of collaborative learning competency for three inquiry activities

	Activity 1	Activity 2	Activity 3

	M	S	M	S	M	S
Collaborative Learning competency	1.54	0.67	1.87	0.73	2.35	0.69

Table 4. The contrasts of coefficients estimated by the unconditional HLM models（N=70）

Fixed Effect	Model 1 (unconditional)				
	Coe.	*SE*	*t*	*df*	*p*
Slope β10	.46	.19	2.42	69	.00

Table 5. The descriptive statistics of reflection on collaboration for different slope groups of three inquiry activities

Group	Activity 1		Activity 2		Activity 3	
	M	S	M	S	M	S
High	1.35	.21	1.91	.25	2.52	.18
middle	1.53	.18	1.97	.26	2.27	.19
low	1.59	.29	1.88	.32	1.97	.25

4. Conclusion

In this study, a ubiquitous problem-based learning system, UPBLS, is constructed for conducting in-field inquiry learning activities by providing learning guidance, an online discussion forum, an e-library and an on-line statistics. A scoring rubric for collaborative learning was developed and implemented to amplify the scaffolding effect. The experimental results show that the rubrics used to assess collaborative learning competency demonstrated reasonable reliability and validity evidences; moreover, the UPBL approach was helpful for students in improving their collaborative competency. The finding of this study implies that, in a properly designed inquiry activity, if the students have enough time to become familiar with the learning objectives, their collaborative learning competency can be gradually promoted. In addition to the ubiquitous learning platform, the scoring rubrics also played an important role in communicating the learning objectives of the scientific collaborative inquiry.

UPBLS not only is useful to assess the collaborative competency of the students, but also provides clear criteria and objectives to guide them to collaborate with group members well. The scoring rubric demonstrates be a very valuable instrument for further research and instruction on collaborative inquiry learning.

Acknowledgements

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Using mobile-based MEILA to enhance EFL learners' idiomatic competence

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Abstract

English idiom acquisition is essential to English learning and application. However, intercultural idiomatic competence is still not adequately reflected in current English as a foreign language (EFL) education. The current study, therefore, aimed to examine the affordances of My English Idiom Learning Assistant (MEILA) on EFL learners' idiomatic knowledge. The participants were 60 students from the Applied Foreign Language Track in a senior high school in central Taiwan. The participants installed the MEILA system in their smartphones and learned 50 English idioms in two weeks, with daily boosters employed to remind them of daily idiom learning. The pre-test, immediate post-test and delay post-test were collected. The results revealed that MEILA system significantly enhanced the students' idiomatic knowledge, as a result of interesting, and associative animations, dialogue samples, live elaboration, and word bank. Pedagogical implications for how MEILA could be utilized to enhance students' English idiomatic competence are provided.

1. Introduction

English learning has been a worldwide phenomenon; however, other than the traditional instructional foci such as vocabulary, grammar, sentence structures, the mastery of English idioms is essential to drastic enhancement of an individual's English abilities and successful interaction with the international society, making it important for language learners to possess a strong knowledge of idioms in order to improve communications and help speakers' language output become more native-like [1]. With the continuous advances in multimedia in recent years, the processing capacity and convenience mobile devices possess have led to the worldwide use of all kinds of Apps to assist language learning. Recent years have witnessed the epoch-making advancement of mobile devices, yielding an alternative to English teaching and learning as mobile-assisted language leaning applied to English teaching and learning [2, 3, 4]. Compared with traditional learning via printed materials or through teachers' lectures, mobile-assisted language learning not only effectively draw learners' attention but also make the acquisition of knowledge in a broader scope, leading to a more autonomous and diverse learning [5, 6, 7].

Previous research on learning of English idioms has been restricted to English-speaking countries; studies concerning the instruction and utilization of English idioms in non-native English-speaking countries (such as Taiwan) remain scarce [8]. Furthermore, mobile apps designed for English learning are more vocabulary-based or test-oriented. Few apps have been developed specifically for English idiom learning.

Accordingly, the researchers conducted this study to examine the affordances resulting from the proposed MEILA system. The following research questions guided the study:

1. Did the MEILA system enhance EFL learners' idiomatic competence?
2. What were the students' perceptions about the MEILA system?

2. Method

2.1. Participants

The participants were 60 students from the Applied Foreign Language Track in a senior high school in central Taiwan. The participants had studied English for around four years through high school and their English proficiency was considered to be at the intermediate level.

2.2. Introduction to the MEILA system

After numerous lengthy discussions with language experts and English-speaking instructors in Taiwan and in America, the researchers selected 50 idiomatic expressions based on their frequency and familiarity (see the Appendix). The MEILA system features diverse self-learning resources for English idioms, including animations, dialogue samples, live elaboration, and word bank. Prior to the visual presentation of those idioms, scripts and sample sentences were brainstormed, so that the amination might be interesting, exaggerating, associative and straightforward (see Table 1). Such animation imprinted the concept of a given idiom on learners' memory. The scripts of the animation and dialogue samples were narrated by English-speaking native speakers. To highlight the cultural differences in idiomatic usage, live elaboration was explained in Chinese. Snapshots of the system were illustrated in Figure 1-3.

Table 1. Scripts and sample sentences of "hit the ceiling"

Scene and character	Script type	Samples
Café handsome boy	Animation	A handsome boy is waiting for a girl in the café. The girl hasn't showed up. The boy looked annoyed and keeps looking at his watch. His hair all goes up and he clenches his feast, saying "Come on! It's 3 o'clock. She's not here yet!"
	Dialogue samples	A: Did you know that Lisa stood Jack up last night? 你知道 Lisa 昨晚放 Jack 鴿子嗎？ B: Really? I bet Jack's so angry that he really hit the ceiling. 真的嗎？我猜 Jack 一定氣得跳腳。
	Live elaboration	各位同學，中文所說的「氣得跳腳」，在英文裡也是如此嗎？其實不是喔！想像一個人非常生氣的樣子，是不是會怒髮衝冠、雙手握拳手舞足蹈呢？所以一個人氣急敗壞的樣子，是 hit the ceiling 喔!
	Word bank	hit 敲打、ceiling 天花板、stand somebody up 放某人鴿子

Figure 1. System interface

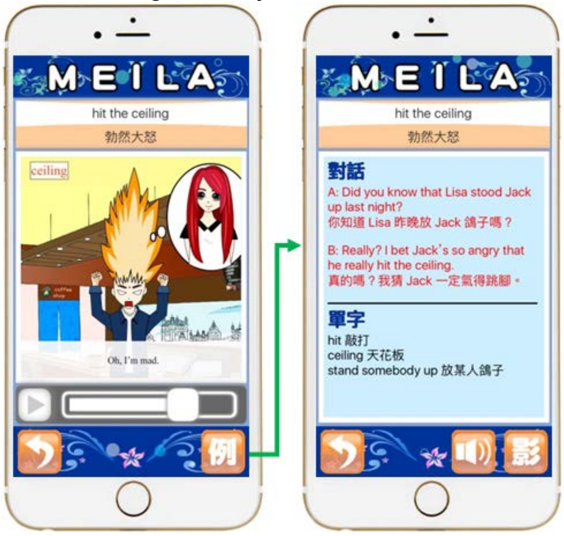

Figure 2. Animation and dialogue samples

Figure 3. Dialogue samples, word bank, and live elaboration

2.3. Research design

In the beginning of the study, the participants were asked to finish a pre-test covering the chosen 50 idioms. Then, the participants downloaded and installed MEILA in their smartphones. Instructions on how to use the system were offered. During the two-week self-learning process, the participants were told to learn four idioms every day. Daily boosters helping them to learn those idioms and to engage them in collaborative discussion context were sent to their LINE group. The participants finished a questionnaire and the immediate post-test after the self-learning process and the delay post-test another two weeks later. Figure 4 visualizes the research design and Figure 5 shows students' responses to the daily booster.

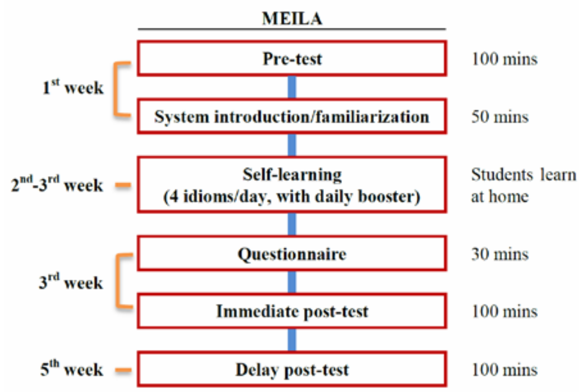

Figure 4. Diagram of the research design

Figure 5. The daily booster

2.4. Data collection and analysis

A pre-test, immediate post-test, delay post-test, and a questionnaire were employed for data collection. The test covered the chosen 50 idioms, including idiom matching (16 items), fill-in-the-blank (10 items), choice (12 items), and sentence making (6 items). The self-developed questionnaire was examined carefully by three experts and modified to meet the purpose of the study, yielding satisfactory face validity. The 27-item questionnaire was further divided into six constructs (Perception about animation, Perception about dialogue, Perceived usefulness, Effects of retention, Perceptions of reminder function through LINE group, and Motivation), and the results of the pilot study revealed a satisfactory reliability ($\alpha = .82$).

The means of the pre-test, immediate post-test, and delay post-test were calculated to examine the effect of MEILA on students' idiomatic competence. Furthermore, a paired-samples t-test was employed to investigate whether significant differences existed in the students' idiomatic learning outcomes and the retention rate of MEILA. Mean scores of the six constructs in the questionnaire were calculated to explore the students' perceptions about the use of MEILA for learning English idioms.

3. Results

The mean scores of the pre-test, post-test, and delay post-test revealed were 47.1, 64.3, and 61.2, respectively. A further examination of the test scores shown in Table 2 suggested that significant differences were found among the three tests (immediate post-test vs. pre-test, delay post-test vs. pre-test, delay post-test vs. immediate post-test). The results indicated the positive effects of MEILA on enhancing the participants' idiomatic competence and its long retention rate.

Table 2. Paired-samples *t*-test of the evaluations

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	SD	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Imme. post to Pre	17.13	16.61	2.14	12.84	21.42	7.991**	59	.000
D. post to Pre	14.03	16.60	2.14	9.75	18.32	6.550**	59	.000
D. post to Imme. post	-3.10	4.28	.55	-4.21	-1.99	-5.614**	59	.000

** $p<.001$

The results of the questionnaire (see Table 3) revealed that the participants' responses to all six constructs fell into the upper-intermediate category, with the mean score of 4.07, 3.98, 3.57, 3.91, 3.65, 3.98 for Perception about animation (A), Perception about dialogue (B), Perceived usefulness (C), Effects of retention (D), Perceptions of reminder function through LINE group (E), and Motivation (F), respectively.

Table 3. Means of the six constructs

Construct	A	B	C	D	E	F
Mean	4.07	3.98	3.57	3.91	3.65	3.98

Based on the results, the animation, dialogue samples, live elaboration, and word bank effectively motivated the students to learn English idioms, and helped them to remember idioms longer. The daily booster offered a collaborative learning setting that successfully kept the idiom learning in process on a daily basis.

4. Conclusion

The results of the current study revealed that the proposed MEILA system significantly enhanced the students' idiomatic knowledge, as a result of interesting, exaggerating, associative and straightforward animations, dialogue sentences that showcasing relevant applications, live elaboration that further highlighted the cultural differences, and word bank providing extra vocabulary information. Such results also demonstrated the affordances that MEILA held in lessening the cross-cultural barriers and in strengthening EFL learners' intercultural competence.

Based on the findings and discussion of this study, the researchers offer the following conclusions and recommendations for practice:

1. MEILA is an appropriate self-learning resource for EFL learners to learn English idioms, leading to beneficial outcomes.
2. Motivation holds the key as such self-learning process is not embedded in the instruction, thus highlighting the importance of eye-catching animations and daily boosters that motivate the learner and keep engaging them in daily learning activities.

The researchers hope that the affordances revealed in this study of self-learning using the mobile-based MEILA will pave the way for further research, and for effective implementation of new and innovative instructional designs in the EFL classroom.

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Effect of a Multi-Criteria Grouping Strategy on Students' Cooperative Intention in Online Learning Activities

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Abstract

Many scholars have pointed out that cooperative learning contains the features of communication and exchange. These features can enhance the overall effectiveness of learning. In cooperative learning, the grouping strategy would affect the effectiveness of learning. Therefore, this study proposes a new grouping strategy which takes prior knowledge, cognitive styles and genders into account. Two students with high complementarity of these three aspects are assigned to the same learning team. The experimental results show that the cooperative intention of the experimental group using the grouping strategy of this study is significantly higher than that of the control group, in which the learning teams were composed by only considering the prior knowledge.

1. Introduction

With the popularity of the Internet and e-learning, cooperative learning has become a frequently adopted teaching strategy. In cooperative learning, it is expected that students help each other and jointly improve their abilities. Tinto pointed out that the "peer relationships" is a very important element in the learning process [1]. The isolated and detached way of learning may lead to failure. Therefore, how to have a good cooperative grouping strategy is very important [1]. In this study, we consider prior knowledge, cognitive styles and genders as multiple human factors, and group two students using the new grouping strategy. Moreover, we explore the effect of the new grouping strategy on stduents' cooperative intention in an online learning environment. The experimental results showed that the cooperative intention of the experimental group using the multi-criteria grouping strategy that considered students' prior knowledge, cognitive styles and genders was significantly higher than that of the control group in which the learning teams were composed by only considering the students' prior knowledge.

2. Literature review

2.1. The development and application of cooperative learning

Cooperative learning has been one of the most popular teaching modes for all levels of schools. Johnson, Johnson and Smith pointed out that in the social interdependence theory, social learning has two relations. One is the positive cooperative relationship and the other is the negative competition relationship [2]. Stahl believed that learning is not a process of transfer of knowledge, but a knowledge creation process in which knowledge is created in the process of talking with others [3][4][5].

2.2. The effect of individual difference on learning

In the past decades, many studies have reported that personal factors could have a critical impact on syudents' learning performances and perceptions. The most frequently considered human factors are prior knowledge, cognitive styles, and genders [6]. In the following, we refer to the literature to illustrate the importance of how these three human factors affect learning.

As to the consideration of prior knowledge, Jenkins, Corritore and Wiedenbeck divided the learners with different prior knowledge and computer experience into four groups, that is, low knowledge/low computer experience, high knowledge/low computer experience, low knowledge/high computer experience, high knowledge/high computer experience. Following that, they explored how the learners used web pages and search for information. Their experimental results showed that the learners with low knowledge/low computer experience usually adopted breadth-first-search when searching for and browsing web information. However, they did not obviously subjectively handle on the search results. The learners with high knowledge/low computer experience also tended to adopt breadth-first-search. However, they used the relevant knowledge as a basis for judging the search results. For the learners with low knowledge/high computer experience, some adopted breadth-first-search, and some adopted depth-first-search. They used general guidelines to handle the search results. The learners with high knowledge/high computer experience tended to adopt depth-first-search priority; moreover, they usually conducted complex and deep evaluation for the search results [7].

In terms of cognitive styles, there are two main sects. One sect is American scholars Witkin, Moore, Goodenough and Cox. They proposed “field dependence” and “field independence” [8]. The other sect is British scholar Pask. He proposed “holist” and “serialist” [9]. Mampadi, Chen, Ghinea and Chen pointed out that the “holist” learners are usually to be adepts in using “Concept Map” to enhance their learning mental structure. They were used to use breadth-first-search and the nonlinear browsing way. The “serialist” learners are preferred to use keyword index. They were used to use depth-first-search and the linear browsing way [10]. In this study, we use the classification way of “holist” and “serialist” to class the cognitive styles.

As to the issue of genders, Koulouri, Lauria, Macredie and Chen reported that, by simulating human-machine interactions, they situated different genders in pair for conducting remote communications. The experimental results showed that genders actually affected task performance and communications. They indicated that if the female guides and male followers were paired to conduct dialogue, the navigation can be completed in the fastest and most precise way [11].

From the literature, it was found that prior knowledge, cognitive styles, and genders indeed affected learning. Therefore, in cooperative learning, it is important to consider these factors when forming cooperative learning teams.

3. Grouping strategy

Hwang, Chen, Loe and Huang used 18-bit of prior knowledge to conduct the grouping of Hamming distance according to Bloom cognitive process ability [12]. This study considers the prior knowledge, cognitive styles and genders further. The assessment indicators of prior knowledge are the same as Hwang et al. [12]. The method is based on Bloom taxonomy of educational objectives. It divides the nine categories of item bank questions into low level cognitive questions and high level cognitive questions. Then, it conducts “heterogeneity priority” grouping according to students’ “HTML Bloom ability code” of 18-bit prior knowledge. The methods of the other two human factors are based on the methods of Hwang, Chen and Tsai [13]. For the part of cognitive styles, we adopt “holist” and “serialist” as indicators. Then, we conduct the 18 questions (17 questions and one reverse question) of cognitive style questionnaire [14]. Based on the respondent results of students, the “heterogeneity priority” grouping of cognitive styles will be conducted. About genders, we use “male” and “female” to conduct “heterogeneity priority” grouping.

First, we encoded the students according to student's HTML Bloom ability code, cognitive styles and genders. These three human factors constituted 54 bit codes as shown in Figure 1. Then, we calculated the Hamming distances and listed a Hamming distance matrix. Finally, the students can be divided into groups according to the Hamming distances. For control group, we conducted Hamming distance calculation and grouping according to HTML Bloom ability code as shown in Figure 2.

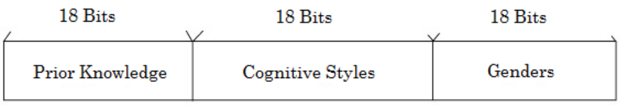

Figure 1. 54 bit codes of experimental group

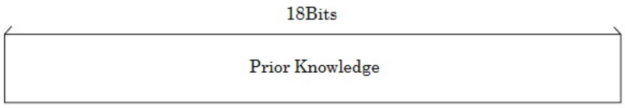

Figure 2. 18 bit codes of control group

4. Research method

4.1. Experimental process

First, we conducted cognitive style test and pre-test for students. Then, we grouped two students together for the experimental group and the control group according to 54-bit and 18-bit grouping methods respectively. After that, we let the students carry out two hours experimental teaching and one hour of cooperation practices per week for eight weeks. Then, we record and analyze the cooperative practice process. The experimental process is as shown in Figure 3.

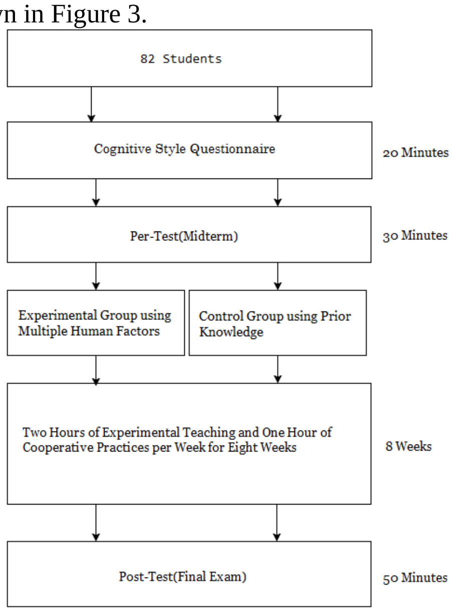

Figure 3. Experimental flow chart

4.2. Experimental subjects

The subjects of this study are 82 students in grade two in the Department of Information Networking and System Administration of a University of Science and Technology in central region of Taiwan. The students were randomly divided into an experimental group of 40 people, a control group of 44 people. The effective samples of full participation were 58 people, of which the experimental group was 28 and the control group was 30.

4.3. Experimental tools

We used the cooperative certification tutoring system which was developed by Hwang et al. [13] as the research tool. The system was a system for a group of two people. The learner's practice process will be recorded in the learning process database.

There are two places that students must respond. One is to input the interpretation of why they choose the answers and the other is to click the confidence of answering as shown in Figure 4. It must satisfy that when the two students both submit the answers, then the system can allow they enter the next step. In addition, if the two students intent to skip the question, it must satisfy that the two students both agree, then the system allow they skip the question. In Figure 5, when the two students submit the answers and the answers of the two students are inconsistent, the system will pop out an alert window to show the answers, interpretation, and confidence and can choose to answer the question using the answers of the partner. In Figure 6, when the answers of the two students are consistent and the answers are not correct, the two students must continue to answer this question until the answers are consistent and correct. In Figure 7, when the answers of the two students are consistent and the answers are correct, the two students can conduct the answering of the next question.

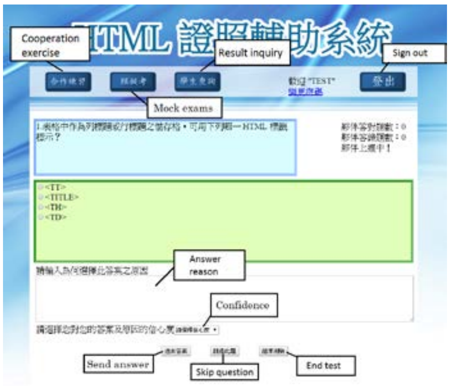

Figure 4. The snapshot of the cooperative practice

Figure 5. The answers of students are inconsistent

Figure 6. The answers of students are consistent but not correct

Figure 7. The answers of students are consistent but correct

5. Result analysis

In this study, we use SPSS19 software to carry out independent samples *t* test analysis. Then, we explore the effect of different grouping strategies on the use of a cooperative certification system. This study found that the use of grouping method of prior knowledge, cognitive styles and genders is more effective to enhance students' willingness to cooperate than the use of prior knowledge grouping method. For the experimental group, the average question number of answering right is 198.07, while the control group, the average question number of answering right is 70.27. As shown in Table 1, by independent sample *t* test, we found that the question number of answering right of the experimental group was significantly higher than that of the control group.

Table 1. The question number of answering right for the experimental and control groups

	Groups	Number of groups	Average number	Standard deviation	*t*
Cooperative question number of answering right	Experimental grouping	14	198.07	206.510	2.149*
	Control grouping	15	70.27	85.879	

*$p<0.05$

6. Conclusions

In this study, we explore the effect of a multi-criteria grouping strategy on the cooperative intention of students who were situated in a cooperative certification tutoring system. The experimental results showed using prior knowledge, cognitive styles and genders for grouping could promoted the willingness of students for using the cooperative certification tutoring system. Therefore, combining multiple human factors into grouping procedure appears to be an effective approach.

In the future, further investigations can be made by integrating our strategy with other learning strategies, such as game-based learning and computer Mindtools, to improve students' learning performances and perceptions, as indicated by several previous studies [15-18].

7. Acknowledgements

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Effect of Encoding Strategy on Students' Pair Learning of Lever Principle from AR Game-Play

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Abstract

This study intended to examine the usability of an augmented reality game-based learning and the effect of type of encoding strategy on elementary student's pair learning performance in lever principle. There were 52 fourth-graders participated in the pair learning activity. The independent variable was type of encoding strategy (the analogy encoding vs. the symbol representation) and the dependent variables were learning performance and motivation towards science learning. The results revealed that (a) for learning performance, the analogy encoding enhanced the application performance better than the symbolic encoding did, and (b) as for the motivation, participants showed positive motivation toward science learning and the symbolic encoding brought about higher degree of intrinsic motivation than the analogy encoding did.

1. Introduction

The purpose of science education was to train up citizens' scientific literacy and spirit while elevating their understanding of the essence of science. However, the scientific concepts were more abstract so that the learners often ignored the quintessence in the concepts [1]. Although the lever principle was introduced in the science textbooks for elementary learners the didactic teaching was not interesting enough to bring about their interest. Moreover, the ineffective combination of abstract concepts in science and concrete operations in the experiment would lead to learners' inability to construct correct mental model for the scientific concepts [2], [3], [4]. Thus, the teachers should design effective and appropriate learning activities in order to facilitate the process of knowledge transmission and improve learners' motivation and performance in the learning.

Digital games being applied in the learning activity could not only assist the learners with the attraction and advantage to activate prior knowledge but also help them engage in the activities [5], [6]. The inquiry and task solving in the digital game-based learning environment could enrich the interest in the learning experience while letting the learners attain the meaning of learning [7]. Unfortunately, learners usually lack of tactile interaction during game play and may fail to transfer their virtual learning experience into the real world. Augmented reality has become a promising means for the connection of abstract concepts with concrete experience. However, internalizing the abstract and concrete representations from augmented reality was never a simple task for the learners due to the extra cognitive load [3], [8]. Providing appropriate visual representation of analogy encoding and semantic representation of abstract encoding while excluding redundant or irrelevant information could be beneficial to the learners [9], [10]. Therefore, this research integrated the viewpoint of experiential learning with the content (lever principle), technology (digital game-based learning environment), and strategy (encoding) to investigate the effects of different encoding strategies (analogy vs. symbolic encoding) on the learning performance and science learning motivation of lever principle for elementary students.

2. Related literature

Games were considered the most potential learning tool due to their assistance with the teachers for the following goals: (a) learners could actively acquire knowledge by hands-on operation rather than being dependent on teachers' illustration; (b) learners could raise their learning motivation and satisfaction in the games; (c) learners of all learning styles and skills could be satisfied; (d) learners could reinforce and master the skills through the games; and (e) interactions and situations of decision making could be given to the learners [5]. Moreover, Yuen, Yaoyuneyon, and Johnson [12] indicated about the application of augmented reality in education: (a) learners could explore the materials in different aspects for the encouragement of learning motivation; (b) learners could directly receive related experience and information in the real environment; (c) the interaction between the learners and teachers could be increased; (d) learners' imagination and creativity could be promoted; (e) learners could be assisted to control their own learning; and (f) learning environment appropriate for learners of every learning style should be provided. On the other hand, conclusive arguments or proofs were still not achieved in terms of the coherent effectiveness between augmented reality and digital simulation or its assistance in understanding higher learning through such effect in the learning performance.

Ainsworth suggested that (a) multiple representation could not only help the learners enrich their learning process but also supplement information to the subject such as important or particular concepts; (b) representation could connect to similar concepts by analogy or inheritance, in other words, using familiar mathematical concept of area could improve the understanding in the learning of unfamiliar concept of torque; and (c) multiple representation could help the learners construct understanding of deeper level and could encourage them for new concepts by providing abstract formula in the teaching materials [2]. Though empirical studies had found that text with related images could give learners the comparison during cognition construction, the learners still needed the organization of visualized images and semantic texts for better understanding [1], [4]. However, analogy encoding visualized the concepts with images representation and was helpful in the transfer of principle concepts [8], [10]; also, image representation was a crucial way for the encouragement of learning and was helpful in keeping relations associated with implicit spaces [2], [4], [8], [9]. In contrast, symbolic encoding refining concepts by formula representation was valuable for learners' understanding during the process of knowledge construction [10]. The research about symbolic encoding (abstract encoding) or situational representation (analogy encoding) with learning guidance strategies revealed that symbolic encoding encouraged the learners to concentrate on the learning tasks; at the same time, learners' repetitive practice in the similar cases could allow the encoding to be built in the intrinsic mental model so that the learners could have good performance in similar situations [11]. Accordingly, conclusive arguments were still not achieved regarding the coherent effectiveness between the analogy and symbolic encoding in the concepts of lever principle, nor was it concluded concerning the helpfulness of its effect over the learning performance on knowledge application.

3. Methods

3.1 Participants

The participants in this research were the 4th graders from an elementary school in Taipei City; these learners all possessed basic computer skills with experiences related to seesaw but were unfamiliar with concepts related to lever principle. There were 52 fourth-graders participated in the pilot pair learning activity, which consisted of four 40-minute sessions.

3.2 The tablet-based AR-Game—"Rescuing the Princess"

The AR-game, "*Rescuing the Princess*", allowed the learners to role-play and assist non-player character (NPC) to solve given tasks in the gaming situations. "*Rescuing the Princess*" included four levels such as fear conquering, experience accumulating, property applying, and magic performing. The learners could proceed the inquiry-based activities according to the storyline on the learning sheet, but the entire process was connected by the linear tasks in the game; hence, the learners could not move to next task when they did not collect the required items or communicate with particular NPC. The tablet-based AR game employed Kolb's experiential learning cycle as the learning framework and consisted of four cyclic stages—concrete experience, reflective observation, abstract conceptualization, and active experimentation. When the learners received the gaming task, they need to communicate with NPC to understand the definition in the lever principle and manipulate the characters to balance the seesaw. Then, as shown in Figure 1, the "analogy encoding" group would acquire feedbacks and hints of area related to weight and torque concepts. In other words, the analogy encoding strategy presents weight and torque concepts in terms of area to enhance learners' understanding of the lever principle. Whereas, as shown in Figure 2, the "symbolic encoding" group would receive feedbacks and hints of unit symbols and formula related to weight and torque. Accordingly, the symbolic encoding strategy presents weight and torque concepts in terms of unit symbol or formula to facilitate learners' understanding of the lever principle. Thus, the learners were encouraged to construct meaningful abstract conceptualization from the concrete experience in manipulating the seesaw and reflective observation of the experience, so that they could further understand and verify the principle of seesaw balance.

Figure 1. The analogy encoding strategy presents weight and torque concepts in terms of area to enhance learners' understanding of the lever principle

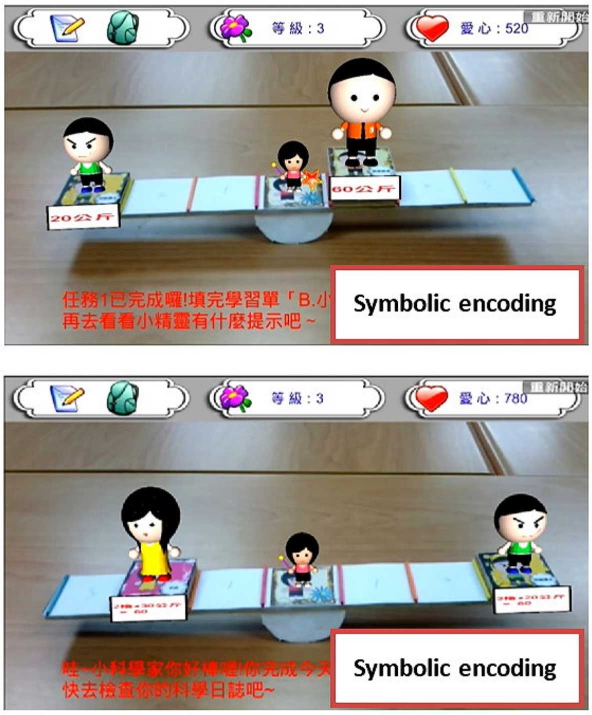

Figure 2. The symbolic encoding strategy presents weight and torque concepts in terms of unit symbol or formula to facilitate learners' understanding of the lever principle

4. Results

4.1 Analysis on learning performance

ANCOVA analysis was conducted to examine participants' learning performance in comprehension and application of the lever principle with prior knowledge as a covariant. As shown in Table 1, the participants' prior knowledge was significant on knowledge comprehension and marginal significant on knowledge application of the lever principle. That is to say, the learners' entry behaviors had significant impact on their learning of the lever principle. Therefore, it is suitable to eliminate the impact of prior knowledge on learning performance for examining the effect of type of encoding strategy. The non-significant main effect of type of encoding strategy on knowledge comprehension indicated that both the analogy encoding and the symbolic encoding had the same level of effect in enhancing knowledge comprehension. Furthermore, the significant main effect of type of encoding strategy on knowledge application suggesting that the analogy encoding (mean=4.56) outperformed the symbolic encoding (mean=3.88) in facilitating learners' knowledge application performance.

Table 1. ANCOVA summary on learning performance

Source	Learning aspect	Type III sum of square	df	Mean square	F	Sig.
Prior knowledge	Comprehension	21.17	1	21.17	6.938*	.010
	Application	10.36	1	10.36	3.689	.058
Encoding strategy	Comprehension	.06	1	.06	.020	.887
	Application	11.31	1	11.31	4.030*	.048

$*p<.05$

4.2 Analysis on intrinsic motivation

MANCOVA analysis was conducted to examine participants' intrinsic motivation toward science learning with prior knowledge as a covariant. As shown in Table 2, the prior knowledge effects were significant and indicated that the learners' prior knowledge had significant impact on their intrinsic motivation toward science learning. Hence, it is necessary to eliminate the impact of prior knowledge on intrinsic motivation for examining the effect of type of encoding strategy.

The main effect of type of encoding strategy was significant on the self-efficacy aspect but non-significant on the active learning aspect and the science learning value aspect. Participants showed positive intrinsic motivation on the three aspects including self-efficacy, active learning and science learning value. Moreover, the significant main effect of type of encoding strategy on self-efficacy indicates that learners receiving the symbolic encoding (mean=3.95) outperformed those learners receiving the analogy encoding strategy (mean=3.57) on the self-efficacy aspect of intrinsic motivation.

Table 2. MANCOVA summary on intrinsic motivation

Source	Intrinsic motivation	Type III sum of square	df	Mean square	F	Sig.
Prior knowledge	Self-efficacy	20.30	1	20.30	39.692*	.000
	Active learning	16.46	1	16.46	33.122*	.000
	Science learning value	18.11	1	18.11	28.102*	.000
Encoding strategy	Self-efficacy	3.46	1	3.46	6.761*	.011
	Active learning	.04	1	.04	.084	.772
	Science learning value	.36	1	.36	.563	.455

*p<.05

5. Conclusions

The findings of this study suggested that using the analogy encoding with AR-based seesaw operations facilitated the leaners to understand the lever principle better than using the symbolic encoding. This finding is consisted with Goldstone and Son's [8] suggestion that the refinement of the formula in symbolic encoding was helpful for learners' understanding during the knowledge construction and the visualized presentation of analogy encoding was helpful for the transfer of theoretical principles. That is to say, the analogy encoding strategy could allow the learners to transfer former concepts about area into new concepts of torque (the multiplication of weight and force arm), so that they could not only possess correct mental mode of lever principle but also have higher levels of thinking ability. Furthermore, from the participants' mental development perspective, the learners of this study were at the concrete operational stage. Providing according concrete information via using the analogy encoding strategy better helped the learners to associate former and new experiences.

Secondly, the AR-game showed positive impact on facilitating learners' motivation; in particular, the symbolic encoding strategy enhanced learners' self-efficacy motivation better than the analogy encoding strategy did. Due to the fact that the AR-Game was built on the learning framework of the experiential learning cycle—concrete experience, reflective observation, abstract conceptualization, and active experimentation, and the learners' role-playing as young scientists integrated the learning tasks in the storyline and made the learning process a meaningful experience; thus, the learners were helped believe in their ability to perform well on the learning tasks and showed high motivation toward learning. Furthermore, the learners receiving the symbolic encoding strategy were given the exact number or formula of the of weight and torque when solving the tasks. They should be more confident in evaluating and balancing the seesaw. Accordingly, they revealed higher self-efficacy motivation than those who receiving the analogy encoding information.

6. Acknowledgement

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Effect of Cooperative WebQuest Learning Model on Computer Science Learning

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Abstract

Dodge and March in 1995 proposed a teaching model called WebQuest, which allowed learners to learn by the internet resources. However, researchers revealed that during the WebQuest learning process, students need real-time help when they encounter problems. The WebQuest teaching model needs to combine a cooperative learning strategy so that students can communicate and discuss the questions they encountered. Hence, in this paper, we propose a cooperative WebQuest learning model to help students construct knowledge by the WebQuest learning model and be able to discuss with peers during the learning process. In our experiments, the participants were 71 students of a Taiwanese high school. The experimental group was taught using the cooperative WebQuest learning model, while the control group was taught by using the WebQuest learning model. The results showed that both two groups of students' learning achievement have increased. Moreover, the cooperative ability of students in the experimental group have significant enhanced.

1. Introduction

With the fast development of the internet and related technology, many researchers applied the internet technologies in teaching for enhancing the learning performance of students. Many researches indicated that students can learn in anytime and everywhere by the internet, and it contains abundant learning resources to utilize and support learning. Dodge and March in 1995 proposed a teaching model called WebQuest, which allowed students to learn by the internet resources.

The WebQuest teaching model includes six parts: (1) introduction, (2) tasks, (3) process, (4) resources, (5) evaluation and (6) conclusion. Teachers have to search helpful internet resources before the courses, and organize them into the resources part, so that students can go to the process part to read all the resources that teachers prepared to help students complete the learning tasks. At the last, teachers can evaluate students' learning performance and conclude the learning contexts. Sen & Neufled [1] indicated that the WebQuest teaching model make the learning process interesting, and it can increases students' learning motivation and participation.

Although WebQuest teaching model has many advantages, Halat [2] mentioned that during the WebQuest learning process, students usually need some real-time help when they encountered problems. Thus, The WebQuest teaching model needs to combine a cooperative learning strategy so that students can communicate and discuss the problems that they encountered.

Therefore, in this paper we adopted a cooperative WebQuest learning model to help students construct knowledge by the WebQuest learning model and be able to discuss with peers during the learning process. Moreover, a learning activity was conducted to evaluate the effectiveness of the approach.

2. Literature Reviews

2.1. WebQuest learning model

Hishor & Cope [3] defined WebQuest as educational activities that allow students use the electronic resources which have been selected, and develop the high mental ability of students by the process of searching, question solving and solution finding.

Sen & Neufled [1] believed that WebQuest can offer learners contact the correct information with least effort, so that learners have more time to develop cognitive process of thinking. This teaching strategy allow students using the internet resources to solve the questions by their own. According to Crawford & Brown [4] and Dodge [5], WebQuest is designed as task-oriented, and it can provide the resources and guide learners to learn by those useful internet resources. Many researchers had applied the WebQuest model to many different fields, such as science [6], medical [7] and geography [8]. Tuan [9] indicated that the English reading achievement of students have significant progress after accepting the WebQuest teaching and students have positive attitude toward WebQuest. Chang, Chen & Hsu[10] mentioned that students acquire more knowledges and learning experiences by using WebQuest in real life, and when students accomplish different learning tasks, they need to express their own opinions, and this process can foster their ability of critical thinking. Hence in this paper, we proposed a new cooperative WebQuest learning model.

2.2. Cooperative Learning

There are lots of different definitions toward cooperative learning. Felder & Brent [12] mentioned that the cooperative learning is a process that will increase learning and satisfaction because students are learning together with a better performance team. The cooperative learning environment can motivate students to solidarity, so that students work together evoke a common goal to complete the task. Wichadee & Orawiwatnakul [13] considered cooperative learning as a teaching strategy, for student with different abilities in a group can improve their understanding through various learning activities. Many studies merged cooperative learning into different courses, and it's helpful for student. Mattingly & VanSickle [14] used cooperative learning in geography, and divide students with different academic achievement to each groups, the results showed that adopt cooperative learning will promote students' learning achievement. Artu & Tarim [15] indicated that after employ cooperative learning in mathematics, students have positive effect toward mathematics. Furthermore, Ahmadpanah et al. [16] showed that rather than just watch and listen to teacher teach the subject, students active solve the questions will learn more. And for those students who face the difficulty always give up easily, the responsible of groups' successful will push them keep learning, the students with higher academic achievement can explain the learning context to others. Wu, Hwang, & Kuo [17] indicated that during the discussion, students can express their opinion related to the web resources, so that they could construct their knowledge and deepen their understanding. Moreover, Sung, Hwang, & Chang [18] expressed that without the connection to the web resources and students' life experience, their learning attitude and learning achievement could be affected, and the discussion between peers play the key to connect the web resources with their life experiences.

3. Research Design

3.1. Participants

In this study, there are total 73 participants in our experiments, consisting of two classes of students in a high school in Taipei. A quasi-experiment method is adopted, and we randomly choose one class as the experimental group and the other class is the control group. In the experimental group, students receive cooperative WebQuest teaching model to learning, and we use the jigsaw II cooperative method for students to form teams. Each student in a team is assigned to learn different task, and has to teach other team members what he has learned during his task. In the beginning of the course, teacher divide students into groups and each group has four students. The students from different groups with same tasks will get together to discuss how to solve the task. After the discussion, they will go back to their groups and teach others how to solve the task. Finally, the teacher conducts a test to evaluate the groups. In the control group, all students receive traditional WebQuest teaching model to learning.

3.2. Measuring tools

3.2.1. Moodle teaching platform. In this study, we adopted a Moodle teaching platform as a tool for supporting the WebQuest teaching model. We first design all the network concepts of computer science as the learning material based on the six elements of WebQuest teaching model.

3.2.2. WebQuest element design. Introduction: the instruction objectives of courses are the introduce the basic concepts of computer network, understanding the composition of computer network, description of the various protocols, introduce various network basic terms and understand the basic operation of network. The situation of teaching is let students become little helper and help teacher solve different questions about the basic network concepts.

Tasks: the courses have twelve different learning tasks, include computer network scope and architecture, network topology, the computer network transmission rate, network hardware equipment, Internet of Things, Computer network transmission media, OSI protocol model, protocol wireless network, mobile communications, IP addresses, domain name server DNS, NIC address MAC and port.

Process: before the courses, teacher has put the prompt which can help students to solve the learning tasks into the process part, students can follow the steps and solve the learning tasks. The teacher can provide appropriate suggestion to support students scaffold their learning.

Resource: before the courses, the teachers have selected and put the sources which include media, books and website in the resource part, and that can help students to solve the learning tasks and help students concentrate on the learning tasks.

Evaluate: before the courses, the teacher put the grading standard of learning tasks in the process part, students can follow the standard to solve the learning tasks.

Conclusion: Before the end of the courses, the teacher explain the solution of the learning tasks and conclude the learning contents.

3.3. Experimental design

This study adopts quasi-experiment design, before the experiment, both students in experiment and control group receive the pre-test of the basic network concepts in order to ensure the difference of prior knowledge. Furthermore, students in experiment not only receive the basic network concepts test, but also receive the cooperative ability pre-questionnaire. Then the teacher will explain the course and divide experiment group into groups. In the experiment, they received cooperative WebQuest learning model teaching, the control group received traditional WebQuest learning model teaching. After the formal experiment, all students receive the post-test of the basic network concepts, and students in experiment not only receive the basic network concepts test, but also receive the cooperative ability post-questionnaire (see Figure 1).

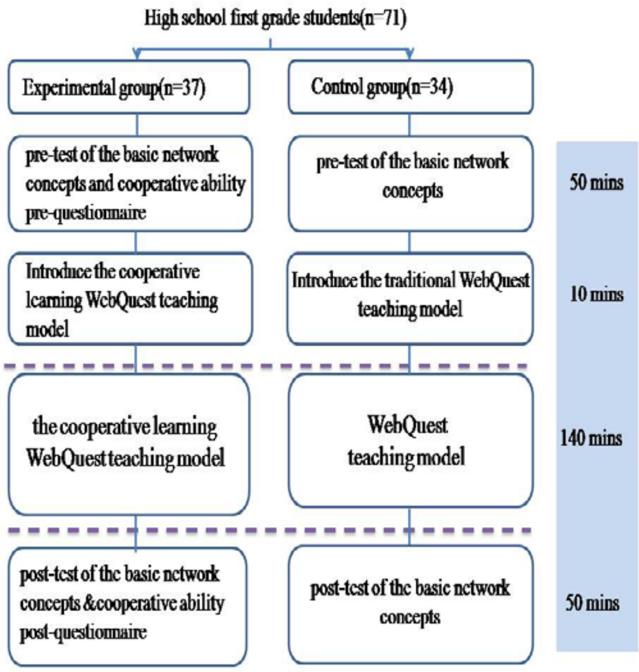

Figure 1. Experimental design

4. Results

4.1 Learning achievement

There are 37 students in the experimental group, 34 students in the control group. The experimental group received cooperative WebQuest learning model teaching, the control group received traditional WebQuest learning model teaching. Both students in experiment and control group receive the pre-test of the basic network concepts test. The scores of pre-test and post-test in the experimental group are 37.43 and 69.72, the scores of pre-test and post-test in the control group are 39.12 and 79.43. The one-way analysis of covariance was employed to evaluate the learning achievement of students in experimental group and control group. The Levene's test of determining homogeneity of variance was not violated (F = 3.71, p =0.058 > 0.05), and the results has no significant different (F (1, 68) = 3.54, p > 0.05), this imply the post-test score of experimental group do not significant higher than control group.

4.2 Cooperative ability

This study would explore the different of cooperative ability after students receive the cooperative WebQuest model teaching. The students have received pre-post cooperative ability questionnaire. The score of pre-test and post-test are 3.22 and 3.54. The pair-sample t test was employed to evaluate the difference of cooperative ability. The results showed that students' cooperative ability has significant increase (t =-3.227, p =0.003) after received the cooperative WebQuest model teaching, it imply that through the cooperative WebQuest model teaching, student's cooperative ability has significant effect (see Table 1).

Table 1. The pair-sample t test analysis of the cooperative ability in experimental group

Variables	N	M	SD	t
pre-test	37	3.22	0.77	-3.227**
post-test	37	3.54	0.71	

** p<0.01

5. Discussion

The results of this study indicated that both students' learning achievements in two groups have increased, but they do not have significant difference. The paper of Zacharia et al. [11] showed that students who received Jigsaw cooperative strategy don't have enough ability to teach other peers, so the cooperative mode tend to traditional cooperative learning mode. In this study, we employed Jigsaw II as the cooperative learning strategy, and the students could not explain the learning contents to other peers, so that the students' learning achievement in the experiment is lower than those of students in the control group. However, after receiving the cooperative WebQuest teaching, the cooperative ability of students in the experimental group has significantly increased. Hence teachers should train students' expression ability before they receive the cooperative WebQuest teaching.

Acknowledgements

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Applying Big Data Analysis to MOOCs Learners' Media Literacy Cultivation on Collaborative Learning

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Abstract

In order to let the public can be good at understand media, communication studies and education start paid attention to the work of media literacy. Teach learner related concept, identify facts and opinion, discuss mass culture of fiction and drama, develop advertising, distribute and persuade the content of teaching method. Media literacy aim civil can classify the media, test the process of making media, analyze the media product, explores the consumer behavior of the media products and understanding the effectiveness of the media. Only if people understand the role of media in the process of knowledge accumulation, in order to have further analysis, are able to evaluate even critics all kind of media information. The last purpose is encouraging citizen to use the media, and fully improve the propagation environment.

The research use (the application of big data analytics techniques to discuss MOOC's learner of media analysis literacy on collaborative learning and adaptive material recommendation), will be implemented – MOOC's community study group, observe learner learn media literacy and interaction process on the internet, use big data analytics signal discuss between learners, speculative ability, reflect on the audience's idea and influence and into use media condition, provide teacher and researcher a visual data.

The research expects to make teacher know student's activity learning of real time data and analysis behavior, proceeding adjustment teaching strategies; let the systems recommend learner be suitable for media material, to reach adaptive individualized learning; let the researcher know the learner's behavior and improve audience's learning status.

1. Introduction

What common topics are become headline or exclusive news when you turn on TV or newspaper every day? Nothing more than politic, gossip, and social case. Children's world has been fulfilled with adult's issue, greeted or to smell, all it has been "explained" by the world. Media have their own positions, each television has their back behind burden, often can be interpreted as normal, ordinary news, but it was hype into after meal gossip's information. What in our children sees in their world? The concept of (media literacy) was form earlier in British at 1930's, at that time educator argue that civil must have critic capability toward public propaganda. Media literacy education in the United States start form since 1960's, when the media advertisement began to prevail [1]. Generally, the meaning of media on media literacy are refer as mass media, education department purpose (White Paper of Media Literacy Education Policy) the meaning of media literacy which consist of: understand media's content information, speculative media representation, reflect on the meaning of the audience, analyze media organization, influence and use media, Ministry of Education department (White Paper of Media Literacy Education Policy) refer media literacy to audiences ability to interpret mass media [2].

In recent years, with the rapid development of big data education, teachers and student's operating process history on the internet can be recorded, the focus attention not only have analysis technique, development tool, and further to draw on these huge data quantities itself, the interpretation of its contain rich of information, so that teacher and student can grasp opportunity to predict future education policy direction. And the application of big data trend also gradually influences the education field, make the student learning process can be recorded, provide teacher to improve and implement adaptive teaching, hence many scholars have advocated collect a lot of learning behavior data for a long time, through analysis to advance learning effect.

And MOOCs shape out some new style which more accord with human nature than classroom teaching. In case of the media literacy education such as: send questionnaire to students before class on academic platforms, understand student's background (age, nationality, sex) learning goals and education degree, so that teacher can timely appropriate moderation adjust to teaching content and direction. At the end of the course, the teacher can make report to the student, the number of enrollment, weekly classes, people which participate in the final exam and get certificate number then conduct the statistical analysis. Teacher not only can give positive feedback in the process of teaching, teacher also can record and improvement measures and teaching plans such as adjusting the basis, even if the end of the course, teacher can keep in touch with student through group on Facebook, and can have face to face communication and interaction. Through (MOOCS plan) online learning model, teacher clearly making curriculum goal and learning progress weekly, and make weekly study course content divided into several units. Each or several units matches between formative assessment, and evaluate student mastery unit, let the student continue to practice, achieve mastery goal of the learning unit. Students conduct self-paced learning every week, prepare recording material before class, and at the same time self-assessment via online, know self-learning condition, proceed train the student to have active learning attitude, teacher and student through the entity class divided into group discussion to proceed collaborative learning, and make teach and learn is not only teacher’s knowledge, and added the interaction between teachers and students.

2. Literacy Review

As become a practical guide, the concept of media literacy theory has much less ambiguous, but can still be found in the study of the theory from different period, earlier initial cause of the media literacy as media commercialization, and damaged media watch and the function of education, the media social responsibility should be control. However today media pursue maximization profit, other side, start advocate media literacy, the self-discipline effect is poor, so that need other rule, media literacy education through audience abilities to eliminate the influence of inappropriate content. In Ontario Canada become the first North America legislation media literacy teaching area, it become the content foundation of communication education, all media content is constructed, construction of real media, audience can self-negotiation about the meaning of information in media, include business content, ideology, the application of social and politic, content and form of media information is one and all kind media have special aesthetic form [3].

Digital media is the microcosm society, repress is the side mirror of society [4, 5]. Thus, digital media is not isolate from the single existence of society and life, it’s being embedded in social and cultural context, at the same time, through the daily life practice, forming as the part of culture digital media. Among, via by digital media of [view] and [appreciate], experience and understand media culture value system is the important pathway [6]. In additional, the combination of digital media and culture is the important key. Through the auxiliary digital media education in digital media and digital media culture of learning, not only can deepen the connotation and the meaning of digital media culture, for countrymen digital media participation in the ethos cultivation also can play its effectiveness of behavior [7]. As compare, [8] has mention, the concrete implementation of the appreciation digital media form the population, toward rich content of sport teaching, construct campus digital media culture, cultivate independent media recognition are deeply meaningful, therefore, through school digital media education pathway, by advance digital media knowledge and ability, practicable digital media behavior, will provide our country to construct the high quality digital media culture, establish the "independent thinking" and "media recognition" of the healthy development of the important foundation.

Adopt Jenkins, Purushotma, Weigel, Clinton, & Robison’s thought [9], regard media as ruling class keep advantage from ideology and it is a tool to control subordinate class, while media education is the weapon to oppose media hegemony. [9] argues media education become gate to know media communication, cultivate media literacy knowledge, with this knowledge will be able to understand the nature of the media and information of production process, proceed resolve, understand media content how to influence self, foster critic, the ability to multi thinking as well as analyze, critics media using a lag sequential analysis approach [10,11]. Can be found from the literature are made by reality face to describe media literacy should have oriented. Most multimedia literacy education research lack of theoretical basis background, and to understand the change of media literacy, we need to inspect from big theory frame. As [12] indicate the transformation of media literacy: the main idea is from protect and immune become career preparation and communication rights, from mass culture become media ecology, culture is defining from elite culture to into all life-style, education aim to confront media become to media mutualism, teaching from analyze and critic media content - to participate and produce content and influence media industry, audience roles from consumer to citizen to producer [13].

3. Methodology

The research expect through the big analysis methodology, collect student’s learning history and their interaction data on MOOCs course, understand the ability of student in media literacy, inflict recommend suit material to student, after repeated study, assessment student’s learning effect, to reach this goal, will use big data analysis method, after verify data sources, using web crawler (scrappy) to crawl all student’s behavior and interaction on MOOCs learning, and these actions, have structure, community semi- structured data formats including: content, author, time, palindrome, the number of like, the number of share, fan page/social group name, fan page/the number of social group, fan page/ social group link, picture hyperlink field, using document guide to database storage [14]. Utilize "Activity Streams" to describe learning experience, through statement to record learning experience, furthermore use semantic definitions transform into structured and extensible data, under the big data background, learning experience data gain provide a guiding framework, continue to use mapping and concluding (reduce), finally the collection data will be summarized up.

4. Experiment

The main experimental subject comes from Northern Taiwan – a one undergraduate courses – computer science students, this course aims to lead student learn the concept and the application techniques of computer science, cultivate student the ability of computer concept and techniques. The teacher has teaching computer science experiences for more than 10 years, teacher conduct to teach computer science in class, the experiment takes course activity during sixth semester which each semester takes 3 hours a week.

The average of people who took class is around 40 people along sixth academic year school down, the research object amount 250. Teacher assort to course content, built 2015 in the edX platform online course on computer science, hereby match up online course of all content, teaching video, augmentation teaching material and test (Figure 1).

Figure 1. Course schematic pictures

Among on the literacy education, through different teaching methodology, several research shows can effectively enhance student's competence in various literacy, while researcher also can get the professional development; but there also research indicate that proceed research, teacher may be due to too many school activities arrangement, and cannot frequently conduct discussion with group, or in the case of cooperate design the course, both sides failed to reach full cooperation condition, thus may reduce the effect. In conclusion, no matter it designed for literacy education curriculum, or blend into other course, are available through action research, as far as possible understand overall student's learning condition, and help teacher promote education professional ability – improve the teaching working. In light of this, the research will take college students as object study, the development of the action research plan for one semester. Using collaboration method between the researcher and teacher, choosing the represent class, the actual implementation of actual plan, and use data collection method, in order to reflect and evaluate the common process and result of teaching:

1. Research diary: record the observation, emotion and reflection in the research process, in order to help inspect all information gathering.
2. Teaching diaries: record the observation of teacher and teaching process, include the academic main point, course goal and student's learning.
3. Behavior and teacher reflection: make objective explanation to research object in all phenomena and behavior.
4. Interview teacher: before MOOCs program implementation, through interview to understand teacher background and withal course goal; after implementation aim at evaluation course goal, curriculum implementation of review and synergies process.
5. Student's interview: after course implementation, divided into group interview in the course of the teaching activities result.
6. Questionnaire survey: before class and after the implementation of the same file, in pretest and posttest, the comparison before and after students participate the course.
7. Other files: include complete content course of learning sheet and product, as the evidence of interview or observation.

5. Disscussion and conclusion

The research takes three years term, the first year apply big data analysis to conduct the integration of media literacy course able to plan and evaluate into communication technology, as develop and construct the course content structure, the second years, apply the first year research result as the foundation, utilize big data analysis to conduct digital material recommendation to learner, and support, develop and test the design material system; the third year rule is make the first and second year research result as foundation, aim at domestic college student to proceed and increase the intervention course to media literacy, reflection and feedback histories, inspect the practice teaching condition, together reflect and review teaching history and result, hereby point out research physic result, provide future domestic media literacy education to become and can increase advice.

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Effects of an Augmented Reality-Based Board Game on Students' Cognitive Load and Technology Acceptance in Learning History

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Abstract

History is often considered a boring course by students because it requires the memorization of large numbers of characters, treaties, and events. The exclusive use of didactic teaching is likely to affect learning outcomes and cause learners to lose learning motivation. In this study, AR and a board game were integrated into a history course to investigate its effect on students' cognitive load; students' acceptance of interactive learning and enjoyment of the board game was also explored. After participating in the activity, experts and participants with various professional backgrounds were interviewed and the feasibility and practicality of the design were verified. The results indicate that both the experts and participants approve the feasibility and practicality of this approach. In addition, to enhance this learning model for students, teaching materials and game content could be improved.

1. Introduction

When learning history, students are required to memorize large numbers of characters, treaties, and events; this is often considered a boring task. Although researchers consider narrative to be useful for overcoming the fragmentation of knowledge of historical characters and events [1], the exclusive use of didactic teaching is likely to affect learning outcomes and cause learners to lose learning motivation. Consequently, researchers conducted a mobile, multimedia game designed for history education and applied it to a narrative learning environment [1]. In another study, a video game was used to teach students the history of WWII [2]. Arguably, game-based learning (GBL) in history education is crucial.

GBL has previously been applied to instruction. Many studies have emphasized that GBL can improve learning motivation. Researchers integrated GBL into health education courses and improved the learning motivation, achievement, and problem-solving competence of students [3]. In addition, the application of GBL for social studies courses effectively enhanced the learning achievement, motivation, and flow state of students [4].

Recently, mobile learning has been implemented in various courses at high schools and elementary schools. Augmented reality (AR) is a technology that superimposes virtual objects onto images of the real world by using the camera and display screen of a mobile device to scan and identify objects and present interactive features. In the past decade, various studies have employed AR in a wide range of course types. For example, an AR guided system integrating art appreciation courses was designed as an auxiliary tool to enhance learning effectiveness through the appreciation of artwork [5]. Furthermore, researchers integrated AR into natural science courses [6]. The results indicate that the method can increase student interaction and thereby facilitate knowledge construction. Thus, AR has been applied to the humanities and social sciences and substantially improved learning. In this study, an AR and a board game were integrated into a history course to explore its effect on students' cognitive load; students' acceptance of interactive learning and enjoyment of the board game was also explored. After participating in the activity, experts and participants with different professional backgrounds were interviewed and the feasibility and practicality of the design were verified.

2. Literature Review

2.1. Game-based learning

GBL refers to learners experiencing a sense of accomplishment from a game through problem solving and overcoming challenges. Research has demonstrated that GBL can enhance learning performance effectively [7], [8]. Researchers developed a contextual educational computer game with an inquiry-based learning strategy to improve students' learning performance [4]. The results indicate that the approach can effectively increase students' learning achievement.

The instructional models of student-centered teaching and learning are increasingly crucial. GBL has been used in many subjects and is recognized as having high potential as an approach for inspiring students [3]. Researchers observed that evolutionary theory is difficult to understand [9]. Thus, they developed a game based on evolution to increase students' understanding of this subject. Moreover, researchers adapted GBL to mathematics to investigate students' problem-solving and problem-posing abilities [10].

GBL could thus improve students' learning outcomes. In this study, GBL was applied to a board game that provides historical information to learners. AR technology was applied in a learning environment to provide an alternative learning model for students.

2.2. Augmented reality

AR is a technology that superimposes virtual objects onto images of the real world by using the camera and display screen of a mobile device to scan and identify objects and present interactive features. In the past decade, studies have applied AR to subjects such as art, mathematics, electromagnetism, and technical creative design [11], [12]. It is considered to have potential pedagogical applications [13].

AR has been gradually accepted by instructors and learners. Researchers applied AR technology to natural science courses and found that compared with conventional inquiry-based learning activities, AR-based learning activities engaged students in more knowledge construction interactions [6].

Many studies have demonstrated that AR has a positive effect on student motivation [11], [12] and can effectively increase learners' learning effectiveness and promote flow states [5].

Thus, AR and a board game were integrated into a history course to determine their acceptability to students and their effect on students' cognitive load. The learning outcomes of interactive learning and enjoyment of the board game were also investigated.

3. Game development and design

Students learning history must comprehend the concept of the timeline. Studying historical events can facilitate students' memory development. In combination with AR technology, a game can integrate many details of historical events into questions and tasks to strengthen students' concepts and understanding of history. In the developed board game, "time" is the core concept. Each card represents an event and has an event name, an image, and three keywords on the front side. The reverse side of the card shows the date, name, and period of the event, and three keywords (Fig. 1). Students understand the causes and effects of events through the images and keywords on the cards and thereby learn historical culture, characters, and narratives. Testing learners' understanding of the relationships among historical events is essential.

Fig. 1. Card information

Before beginning the game, each learner draws two cards from the event cards and randomly takes four cards from the event cards on the table that were placed with their reverse sides facing up. The student then arranges his or her cards chronologically from left to right (Fig. 2). The game aims to familiarize learners with a particular period through the information provided on the cards. When each learner plays, he or she uses the information on the cards to place the cards in the correct order on the timeline. If learners are unable to determine the age of cards, they can employ mobile devices to scan the cards using AR technology for additional descriptions of events. When a learner connects three cards correctly, he or she receives one point. After all of the event cards are drawn by learners, the game is finished. Scores are then counted and the player with the highest score wins the game.

Fig. 2. Game scene

Fig. 3. Learner reading card information by using a mobile device with AR

4. Method

4.1. Participants

The game was developed through Unity, and the game content was designed in accordance with the Taiwanese history curriculum. To integrate history into the game effectively, two history education researchers and a middle school history teacher were invited to design the rules of the game. In addition, middle school history teachers and college students majoring in information management were invited to repeatedly test the game to ensure its content validity and playability.

4.2. Instruments

This study employed a questionnaire on cognitive load, satisfaction, and technology acceptance to analyze the game. The questionnaire on cognitive load was based on the scale proposed by [14] and [15]. The questionnaire consists of two dimensions with a total of eight items, namely five items on mental load, and three items on mental effort. The questionnaire on learning satisfaction was based on the scale proposed by [16] and consists of seven items. The questionnaire on technology acceptance was developed with reference to [17]. The questionnaire consists of two dimensions with a total of thirteen items, namely six items for perceived usefulness and seven items for perceived ease of use. The questionnaire items were scored with a Likert-type 7-point scale.

5. Results and discussion

Learning history requires memorizing large numbers of characters, treaties, and events and is often considered by students to be boring. In this study, AR and a board game were integrated into a history course to determine their acceptability to students and their effect on students' cognitive load; the learning outcomes of interactive learning and enjoyment of the board game were also explored. Table 1 presents the descriptive statistics regarding learning satisfaction. The results show that the students accepted the learning model and were satisfied with the integration of AR and the board game in history learning.

Table 1. Descriptive statistics for learning satisfaction

Satisfaction of learning model	M	SD
Using this approach for learning is more interesting than past learning.	6.75	0.463
I think that using this approach for learning could help me find a new problem.	6.63	0.518
Using this approach for learning, I think that I could make a new way of thinking to read the learning content.	6.25	0.886
I like to use this approach for learning.	6.38	0.518
I hope that other subjects could also be learned through this way.	6.00	1.309
I hope that I have the opportunity to use this approach for learning.	6.00	0.756
I would recommend this learning to other students.	6.00	0.756

Table 2 presents the descriptive statistics regarding perceived usefulness. The results show that adopting mobile devices in studying by using a highly interactive board game in a peer competitive environment is useful and beneficial for learning outcomes compared with conventional computer-assisted learning.

Table 2. Descriptive statistics for perceived usefulness

Perceived usefulness	M	SD
I think that the more plentiful contents are learned by using the learning method.	5.88	0.641
I think that the learning method is useful for me to learn new things.	6.38	0.518
The learning guide mechanism provides a smoother learning process for me.	6.25	0.707
The learning method could help me get useful information when I need.	5.75	0.707
The learning method allows me to learn better.	5.63	0.744
The learning method is more effective than a conventional computer-assisted learning.	5.87	0.991

Table 3 presents the descriptive statistics regarding perceived ease of use. The results indicate that the learning model is an easy-to-use system.

Table 3. Descriptive statistics for perceived ease of use

Perceived ease of use	M	SD
In the learning process, the operating system is not difficult.	6.38	0.518
In the learning process, I do not need to spend too much time.	6.13	0.835
The content of the learning activity for me is clear and easy to understand.	6.25	0.463
I learn and understand the operation of the system very soon.	6.38	0.518
In the learning activity, the learning process of the operation system for me is not difficult.	6.38	0.518
I think the interface of the learning method is easy to use.	6.50	0.535
Overall, the learning system is easy to use.	6.50	0.535

Table 4 presents the descriptive statistics regarding cognitive load. The results indicate low cognitive load; however, testers evaluating the learning material, instructional model, and teaching activity design reported that too much information is provided in AR, thereby causing cognitive load for learners. Testers recommended improvements to provide the appropriate quantity of information to learners. The content of the board game describes nearly 400 years of Taiwanese history, and learners have limited prior knowledge with which to play the game. Therefore, reducing the length of the historical period employed and conducting the game based on cards relating to a limited period were recommended as means of reducing learners' cognitive load.

Table 4. Descriptive statistics for cognitive load

Cognitive load	M	SD
The learning content for me is difficult.	1.88	1.126
I spent a lot of efforts to answer this question in the learning activity.	2.13	0.641
Answering the question of activity is very tiring.	1.63	0.518
Answering the question of activity is very frustrated.	1.38	0.518
I do not have enough time to answer the question in the activity.	1.75	0.886
The way of explaining contents in the learning activity causes me a lot of pressure.	1.63	0.744
I have to spend a lot of efforts to complete the task of learning or to learn this course.	1.50	0.926
The way of explanation in the learning activity is difficult to understand.	1.25	0.463

In conclusion, researchers indicated three cognitive load factors in the teaching process, namely prior knowledge, course structure, and the organization of teaching materials [18]. Thus, to improve learning motivation and achievement as well as reduce cognitive load, revising the teaching materials and game content to provide learners with an enhanced learning and teaching environment is proposed.

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The Influences of Cognitive Styles on Assessment Differences in the Context of Peer Response

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Abstract

Among various collaborative learning approaches, peer response can facilitate students to evaluate their works for improvement. On the other hand, English and writing ability are indispensable skills for students. Accordingly, we developed a Group-based Peer-Feedback Writing System to enhance students' English writing abilities. However, individual differences, especially cognitive styles, exist among students and such differences might affect students' reaction to peer response. To examine how students react to peer response differently, a cognitive style perspective (i.e., Holists and Serialists) was adopted in this study. Furthermore, the differences between teachers' feedback and students' feedback were also investigated. The results reveal some interesting findings. In general, the students and teachers performed similarly in assigning patterns in the first works whereas they reacted differently in the revised works, where the students gave lower scores than the teachers. Furthermore, Serial students were not able to recognize the improvement made in the revised works.

1. Introduction

Among various collaborative learning approaches, peer response can stimulate students to develop capabilities in monitoring and evaluating their works [1]. On the other hand, English becomes an international language in resent years and writing can facilitate language development [2]. Therefore, researchers attempted to foster students' English writing ability with peer response. Such researchers found that peer response is useful for the improvement of English writing [3][4]. In spite of such usefulness, not all of students can deliver appropriate feedback during the process of peer response. For instance, Gedera [5] claimed that students were not able to identify their peers' mistakes due to inadequacy of the proficiency so they might not be able to give precise comments to their peers. Such a finding revealed that the feedback from peers might not be as helpful as that from teachers.

The other factor that might affect the quality of feedback is students' individual differences. Among various individual differences, cognitive styles affect how people process and organize information [12]. In particular, Pask's Holism/Serialism [6] is considered as an influential cognitive style in educational settings, where learners with a holistic style tend to take a global learning approach while those with a serialistic style prefer to use a local learning approach. Because of such different learning approaches, Holists and Serialists demonstrated different learning patterns when using digital learning tools. For instance, Chan, Hsieh and Chen [7] investigated how Holists and Serialists used electronic journals via mobile devices, and found that Holists favored to use the Basic Search that can obtain an overall picture while Serialists preferred to use Boolean operators to obtain specific details via the Expert Search. In brief, great differences exist between Holists and Serialists (Table 1) so they may use different learning approaches. Such differences may also affect how they deliver feedback during the process of peer response.

Table 1. Differences between Holist and Serialist characteristics [8]

Holists	Serialists
Take a global approach and create conceptual links between objects early on.	Take an analytical approach, examining individual topics before forming conceptual links.
Are able to move between theory and real world examples from the beginning.	Analyzes theory or real world examples separately, only joining together if necessary.
Broad focus; likes to have more than one thing on the go at the same time.	Narrow focus; prefers to focus on completing one task before moving on to the next.
Process information in a "whole-to-part" sequence	Take a "part-to-whole" processing of information.
Internally directed.	Externally directed.

In other words, assessment differences might not only exist between students and teachers, but also appear between Holists and Serialists. In this vein, this study aims to examine assessment differences between students and teachers and between Holists and Serialists in the contexts of peer response. By doing so, this study can contribute complete understandings of the reliability of peer response. Such complete understandings can provide guidance for the development of effective peer response in future educational settings.

2. Methodology design

To achieve the aforementioned aim, we developed a Group-based Peer-Feedback Writing System (GPWS) and conducted an empirical study. The details are described below.

2.1. Development of the PAWS

The GPWS was developed in this study. The GPWS was implemented on the Internet Information Services (IIS). Thus, both authors and assessors could access the GPWS via the browsers with convenience. By doing so, the authors could write academic papers conveniently and the assessors could easily give comments as well. Moreover, the GPWS provided multiple functionalities for authors and assessors. More specifically, the authors could not only re-examine the suggestions obtained from students and teachers but also reviewed their previous drafts anytime when they did the revision. On the other hand, the assessors could re-check their previous comments to do the assessment correctly (Figure 1).

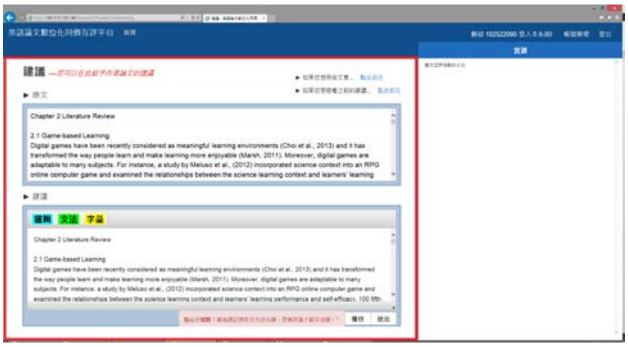

Figure 1. The design of the GPWS

2.2. Empirical study

A total of 18 individuals, including 16 students and two teachers from a northern university in Taiwan, participated in this study. The students were undergraduate and postgraduate students. On the other hand, both teachers have sufficient experience in academic English writing. At the initial stage of the experiment, Ford's SPQ [9] was applied to identify the participants' cognitive styles. The results of the SPQ indicated that there were eight Holists and eight Serialists. In order to help the participants know how to act as assessors, they were provided a series of three-hour training courses, which lasted for ten weeks. In the end of the training courses, the participants were instructed how to use the GPWS to do assessments. After completing the training courses, the participants started to do the assessment for four works and such assessment took place twice, including the first draft and revised draft. Accordingly, the students and teachers needed to assess eight works, including four first drafts and four revised drafts. The assessment activities are summarized in Table 2.

Table 2. Assessment activities

No.	Activities	Purposes
1	To write the first draft	The authors needed to compose the first draft, which introduced their own research topics.
2	To assess the first draft	Both of the students and teachers gave comments via the PAWS and filled out the marking sheet for the two first drafts that the teachers randomly chose.
3	To do the revision	Authors had to revise the first drafts according to the comments from the students and the teachers.
4	To assess the revised draft	Both of the students and teachers gave comments via the PAWS and filled out the marking sheet for the two revised drafts.

2.3 Data analysis

To examine assessment differences between students and teachers from a cognitive style perspective, a quantitative approach was applied to collect scores from the students and the teachers and data analyses were conducted with the Pearson's correlations and Paired T-test. Pearson correlations could be used to interpret the strengths of a statistical relationship between two random variables [10] so the consistency between scores from the students and those from the teachers could be obtained. The Paired T-test could be used to discover score differences between the first version and the revised version, including scores from the teachers and scores from the students. This is owing to the fact that the Paired T-test is suitable to investigate the differences between paired data of one group [11].

3. Results and discussion

3.1. Consistent vs. inconsistent

The results from Pearson correlations indicated that there was a significantly positive correlation between the overall scores from the students and those from the teachers in the first draft (r = .986, p = .014) but such a significant correlation was not found in the revised draft (r = .867, p = .133). In other words, students and teachers demonstrated a consistent marking pattern in the first draft but such a consistent marking pattern was not found in the revised draft.

Pearson's correlations were also used to compare the marking patterns of the Holists (p>.05) and Serialists (p>.05) with the teachers'. The results indicated that there was no significant correlation between the overall scores from the Holists and those from the teachers, and between the overall scores from the Serialists and those from the teachers. In other words, neither the Holists nor Serialists showed a marking pattern that was consistent to the teachers, regardless of in the first draft or in the revised draft

3.2. First draft vs. second draft

There were significant differences between the scores of the first draft and those of the revised draft in teachers' assessment (p<.01) while such a significant difference was not found in students' assessment (Figure 2). These findings revealed that authors' understandings were enhanced after they received the feedback from their peers and the teachers. Thus, some improvement was made in the revised draft. However, the teachers could identify the improvement that authors made but students failed to do so. This might be because teachers and students had different levels of expertise in reviewing authors' revised works. In general, teachers had a high level of professional expertise whereas students had a low level of professional expertise. Accordingly, it was easy for teachers to identify the improvement that authors made but students might feel difficult to identify such improvement. This might be the reason why the teachers and students did not demonstrate a consistent marking pattern.

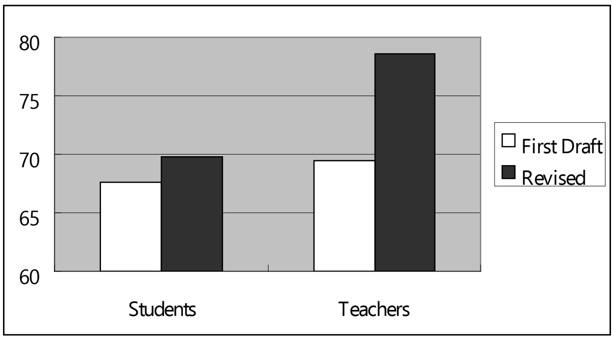

Figure 2. Differences between students and teachers

Furthermore, differences between the Holists and Serialists were also examined. The results indicated that the scores that the Holists gave for the first draft and those that they gave for the revised draft were significantly different but such a significant difference was not found for the Serialists (Table 3). In other words, the Holists were better at identifying the improvement than the Serialists.

Table 3. The paired t-test of the overall score

Version	Mean	SD	*t*	Sig.
Students				
First draft	67.596	10.513		
Revised draft	69.796	10.527	-1.892	0.063
Holists				
First draft	66.258	11.289		
Revised draft	69.208	11.271	-2.410	0.023*
Serialists				
First draft	68.933	9.681		
Revised draft	70.383	9.885	-0.798	0.431
Teachers				
First draft	69.469	9.790		
Revised draft	78.594	6.233	-5.869	0.001**

Keys: * p < .05, ** p < .01

3.3 Qualitative results

After examining the comments that the Holists and Serialists made, we found that they emphasized on different aspects. More specifically, the Serialists, who preferred to use a local learning approach, paid attentions to the details presented in the content. Conversely, the Holists tended to take a global learning approach so they were concerned with the structure of the work. Furthermore, the Holists usually used straightforward sentences to compose their comments while the Serialists could give detailed comments, which could not only clearly indicate the mistakes that an author made but also express how the author should revise their woks. Table 4 presents the examples of comments made by Holists and Serialists.

Table 4. Examples of comments

Cognitive styles	Comments
Holists	● I don't know the key theme of this section. ● The structure of this section did not match with the topic.
Serialists	● The topic of this paragraph is "Experiment Procedures" so I consider that the "Three stages" is the main point, instead of "students". ● Why the "student" is singular? Does it mean a specific student? If not, I suggest that you should use "students" to represent all of the students.

4. Concluding remarks

The results from this study indicated that the students and teachers have more consistent assigning patterns in the first draft while some assessment differences existed between students and teachers in the revised draft. More specifically, the students assigned lower scores for the revised drafts than the teachers. In particular, the Serialists could not identify the improvement made in the revised drafts. These findings entailed that it is urged to provide additional support for the students, especially the Serialists, to enhance the reliability of peer response.

The findings from this study have showed assessment differences between students and teachers in the context of English writing. However, there are some limitations in this study. One is that this research only used a small-scaled sample. Thus, it is recommended that further research should be performed in a larger sample to provide more comprehensive evidence. Another limitation is that only one cognitive style was investigated. Therefore, it is necessary to consider other cognitive styles or human factors, such as Field Independence / Field dependence and gender differences in future research. By doing so, complete understandings of how to conduct effective peer response that can accommodate students' individual differences can be provided.

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Visual Communication in Peer Assessment of Online Collaboration: Exploring the Use of Emojis for Grading Teamwork

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Abstract

Peer assessment in online collaborative learning has been praised by educators in higher education as an invaluable strategy for promoting higher-order-learning, desired social behaviors and co-construction of knowledge. This paper presents a proposed custom design of a discussion forum and secure peer assessment environment. The design makes use of emoji characters for the purpose of allowing the assessor to annotate forum posts, indicating items which have contributed to the grading, and providing feedback to the team members. The emojis from an annotated post are also available to the assessor as items on the team member's "scorecard" and used to match rubrics criteria. Design, development and evaluation stages are presented.

1. Introduction

Contemporary researchers continue to emphasize the importance of peer assessment in online collaborative learning [1,2,3]. They point out that peer assessment not only allows students to gain experience applying evaluation criteria and communicating feedback, but also provides them with higher order learning opportunities such as exercising their critical thinking skills and comparing their perspectives of issues with those of other students. Moreover, as Fisher, Phelps and Ellis [4], and Curtis and Lawson [5] point out, the process of collaboration also engenders particular valued behaviors, such as:

- providing help or assistance;
- providing resources and references;
- elaborating on issues;
- sharing experiences;
- giving feedback;
- critiquing contributions;
- encouraging others;
- acknowledging other's efforts and contributions.

Swan, Shen and Hiltz [6] note that students view the process of collaborative online discussion as "more equitable and more democratic than traditional classroom discussions", and contend that to be successful, online collaborative discussion must be assessed at the level of the individual postings. However, they also warn that care must be taken in selecting a discussion posting content grading strategy that addresses the quality as well as quantity of contributions from students, and suggest that providing assessment rubrics may be the best approach. They point out that rubrics can adequately cover various main aspects of collaboration from the amount of information provided, to the quality, originality and relevance of the contribution and the manner in which it is presented. While concerns have been voiced over the reliability and validity of peer assessment [7], Sluijsmans [8] suggests these issues could be addressed by providing students with clear and concise peer assessment criteria and instruction on how to apply the criteria.

Emojis, characters based on manga art and Japanese Kanji characters, are seen as "a mechanism to provide contextual information and emotions" [9]. Considered as a further development of emoticons, which have been commonly used in computer-mediated communication (CMC) for over 30 years, emojis are seen as leading the way in visual communication. Jingqian, Sung and Jiarui [10] claim that emojis are challenging text-based communication networks by allowing people to present negative feedback in a positive way: "making the emoji soften the blow of assessment".

This paper will present the conceptualization of a research project that aims to investigate the use of emojis as an annotation tool for grading discussion forum contributions of team members collaborating on a series of written course assignments.

2. Background

Findings of a pilot study in online peer assessment [11] led the author to further research online collaboration through CMC as his doctoral research [12]. Consequently, the author designed a blended learning activity in which students, in groups of 8 or 9, used their group discussion forum to assist their leader in writing a paper on the assigned topic for that week.

Group leadership was rotated weekly, so each member had a turn at being leader, and the leader was tasked with writing the assignment paper as well as a brief summary of the discussion posts. The course instructor graded the group leader's submission, while the group leader anonymously graded each member of the team based on their contribution. Ten percent (10%) of the course grade was apportioned to peer assessment.

A secure grading site giving restricted access to the group leader was developed for the purpose of grading the team members. The site included assessment rubrics designed to assist the leader in grading the team member's contributions and performance. Grading issues covered the quality of the information and ideas provided by a team member, the amount of information the team member provided and how collegial and supportive they had been.

During the summative evaluation phase of the research, feedback from student questionnaires and interviews, as well as data analyses of the postings and peer assessment results, indicated that this assessment strategy of online collaboration was effective and widely supported by the students. Commenting on why they had spent more time gathering information for this particular course activity, one student wrote that they had hoped "to help the group with more ideas but more importantly provide the leader with more info" [12]. The belief that the weekly grading of contributions to the online discussion would pressure everyone to do their work was the top ranked reason for feeling that group members were trustworthy, one student wrote, "to be very practical, the ratings of each member's contributions to the forum should well motivate the members to participate in the discussions, moreover, each of us will have a turn at being the leader of the discussion, and have to submit a position paper on the topic, I am sure we all could empathise with the leader, and not put him or her at a spot." [12].

However, the recommendation in the literature advising that online collaborative discussion should be assessed at the level of the individual postings [6], [13,14] was not addressed in this initial design. Hence an updated version providing a simple intuitive way for the team leader to annotate each posting with grading information is proposed. The new research project will investigate the use of emojis as a means of flagging posting segments that relate to the assessment criteria.

3. The Proposed Design for Assessing Collaboration

Booth and Hulten [13], and Schrire [14] point out that a qualitative analysis of discussion forum postings is necessary for an in-depth understanding of the essence of the learning experience. Thus, peer assessors need to be able to identify elements within a post that show evidence of critical thinking. These would include statements that compare and contrast, explain causes, provide an analysis or support perspectives, relate or apply knowledge to a different context. Assessors also need to identify statements that present important factual knowledge and note other information such as bibliographic references, web site hyperlinks, and statements that are collegial and acknowledge or encourage others. Consequently, in order to grade the complete contribution of a team member, a simple method of collating the contributions in each post is required. However, while researchers have attempted to simplify the procedure for analysing discussion forum posts [15, 16], this continues to be a challenge [16].

The design proposed by the author provides the assessor with a limited array of emojis that are conceptually related to the nature of the assessment. Initial suggestions for emojis include:

- Exploding fireworks emoji
  - critical thinking - exceptional contribution
- Bright light bulb emoji
  - critical thinking - commendable contribution
- Building block topped with cement and trowel emoji
  - item of important factual knowledge
- Open book emoji
  - bibliographic reference
- Communication tower emoji
  - web site hyperlink
- Thumbs-up emoji
  - collegiality

When reviewing a team member's post, the assessor can "drag and drop" these emojis into the text of the post to indicate that a specific contribution has been noted. Once a post has been assessed, the author is only able to view it with its emoji annotations, editing is not possible. The emojis that have been added to a post are also added to the team member's assessment "scorecard". Accessible only by the assessor, this "scorecard" presents a record of the member's contributions. The number and type of emojis accumulated are linked to rubrics assessment criteria. For example, the "Excellent" level of a rubric used for grading contributions to the prescribed topic may require six or more bibliographic references or web site hyperlink emojis, the "Good" level: three to five emojis; the "Satisfactory" level: one or two; and the "Poor" level: none.

4. Methods

In order to evaluate the intuitive nature and associated feelings of the proposed emojis, both students and teachers will be consulted through surveys and focus groups sessions. After an analysis of the evaluation data gathered, the selection of emojis will be confirmed and a rapid prototype created. This prototype will only emulate the intended design and serve to examine the use of the emojis in a simulated context. Similar to an inter-rater reliability test, consistency in applying the emojis to a standard text will be examined.

Following the prototype testing and analysis of the feedback, a software development team consisting of a leader/instructional designer, a programmer, a systems engineer, a graphic artist, and faculty who will be piloting a CMC collaborative activity, will be formed. The team leader will create the flowchart and storyboards with consultation from the team, and manage the development schedule. The proposed design will include building a custom discussion forum environment that meets the requirements of the peer assessment activity and provides the instructor with either a random or selected assignment of students to groups. A secure site for peer assessment will also be created. It will allow the group leader to access and annotate team member's posts with the available emojis. The secure site will also provide the leader with a team member's "scorecard", indicating the total accumulation of emojis from all annotated posts, and an assessment rubric for each area of assessment.

Once the beta version of the software has been created, it will then be tested for technical reliability. Concurrently, the interface design and user instructions will be tested for user-friendliness and clarity. The beta version will then be used to facilitate a small group (3 to 5 students) CMC collaboration activity in which groups must submit papers on research topic issues. Non-obtrusive monitoring of peer grading, as well as the complete online activity, will be undertaken and post-activity interviews will follow.

5. Conclusions

Emojis have taken centre stage in recent years. They are invading our mobile communication, have been featured in marketing initiatives of major brands such as McDonalds, and have received world recognition, as in the case of the "Face with tears of joy" emoji, named "word of the year" (2015) by Oxford Dictionaries. Hence, they are increasingly becoming part of the lexicon many of our students recognise and use on a daily basis. However, few applications have been developed and little research has focused on the effectiveness of using emojis in the context of collaborative learning through CMC.

This proposed design, development and evaluation of a custom CMC for small group collaboration and peer assessment aims to provide a pragmatic approach to exploring and understanding visual communication in collaborative CMC. The design stage will start in the fall semester of 2016 and development, concurrently with formative evaluation, is expected to run into the spring and summer of 2017. A progress report will be tabled at the end of the spring semester 2017.

Through this endeavour, the author also hopes to spur further research into the impact of visual communication on learning and social constructivist pedagogy. While the link between the paradigm of social constructivism and collaborative CMC activities may seem evident, Fitzpatrick and Donnelly [17] emphasize the fact that it needs to be constantly re-examined. For example they point out that "technical advances of computer-mediated communication tools and collaboration tools are presenting challenges to what writing and reading really are."[17, page 12]. New research needs to focus on the shared meaning of emojis and the roll emojis play in the co-construction of knowledge.

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Can Peer Interaction Enhance English Learning Among An Online Learning Community?

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Abstract

Several current Internet learning platforms are based on self-directed learning. However, because of the lack of interaction, most learners easily lose interest and gradually stop using these platforms, which results in poor learning achievement. Substantial research has indicated that the interaction between learners and the learning community is critical to education. Hence, the present study integrated an English learning system with an online learning community to determine whether peer interaction enhanced learners' achievement and the amount of time spent using the system. Participants were recruited from an English college course and divided into two groups. The students in the experimental group used the English learning system with the online learning community, and the students in the control group only used the English learning system. After 8 weeks, the results demonstrated that students who had access to the online learning community used the program more often, compared with the students who used the English learning system alone. Moreover, higher interaction among learners in the online learning community yielded greater learning achievement.

1. Introduction

With the advancement of computer technology, numerous online learning courses have emerged, with several advantages. For example, students can learn at their own pace without limitations on space or time. However, motivation for and participation in the activities generally cannot be sustained long term without assistance. To resolve the problem, researchers have proposed sending reminders and learning content through email [1, 2, 3] or a short message service (SMS) [3] to foster study.

Nevertheless, these systems remain a solo endeavor, and students lack interaction with other learners; this is problematic, according to community psychology, because peer interactions are essential to learning [4, 5]. However, with the popularity of social media, online learning communities have gradually formed around enhanced learning, and attracted the attention of educators and researchers [6, 7, 8]. Therefore, this study developed an English learning system embedded in Facebook to form an online learning community, and subsequently explored whether online learning communities and online peer interaction affect learning achievement and engagement.

2. Method

2.1. Research design and Participants

A total of 62 university students who were enrolled in an English course in two classrooms were recruited as participants. Students in the experimental group (15 males and 13 females) used the learning system with access to the online learning community. The remaining students comprised the control group, and used the learning system without access to the online community.

2.2. Research Hypotheses

Hypothesis 1: There is higher usage time on the learning system when students using the learning system with online learning

mmunity, compared with those using the learning system individually.

Hypothesis 2: There is higher learning achievement when students using the learning system with online learning community compared to those using the learning system individually.

Hypothesis 3: Students with higher online peer interaction have more usage time than those with lower online peer interaction.

Hypothesis 4: Students with higher online peer interaction have higher learning achievement than those with lower online peer interaction.

2.3. Learning Community Assisted English Learning System

In the experiment, two English learning systems were established, one with and one without an online learning community. The community-assisted English learning system was used by the students in the experimental group. The group function on Facebook was customized for the learning community by applying the Graph API and Facebook Query Language. As depicted in Figure 1, the system consisted of four parts. The middle part was a multiple choice English test that comprised vocabulary, grammar, and reading comprehension questions. After the students submitted the test, the system immediately graded responses and provided correct answers and instruction. The upper left corner of the system showed users' friends who had also registered for the learning system; users could access their friends' learning statuses, including login times, usage times, and the number of correct answers given.

The lower left corner of the system provided information and a bulletin board about the learning community. The right side comprised a discussion board provided by Facebook, which the students could use to interact with each other.

For the control group, only the middle part of the system was presented. These students completed the test and received instruction, but were unable to interact online with a learning community.

Figure 1. Snapshot of online learning community assisted English learning system

2.4. Instrument

The learning achievement tests are used in the experiment. There are 30 multiple choices covered English vocabulary and reading comprehension in the pretest and posttest. The difficulties of pretest and posttest are similar.

2.5. Procedure

During the first week, the two groups of students took a pretest prior to joining the learning system. Subsequently, the students were encouraged to use the learning system after class for 8 weeks. The students in the experimental group used the learning system with an online community component that enabled them to interact with their peers (see Figure 1). The students in the control group used the learning system individually without an online learning community. After 8 weeks of intervention, the students took the posttest.

2.6. Data collection and analysis

The data were analyzed using SPSS 12.0 (Statistical Package for Social Sciences). The significance level was set to 0.05 since it is the most used value in educational studies. The purposes of this study were to examine whether online learning community and peer interaction affect students' learning achievement and learning engagement. In this study, system using time was to represent learning engagement. Based on the number of message on Facebook, the students of the 27% highest and the 27% lowest interaction were compared. Learning achievement and learning engagement were analyzed through independent sample t test and one-way ANCOVA (Analysis of Covariance) respectively.

3. Results and Discussion

3.1. Effect of online learning community on leaning engagement

The system usage times were analyzed and compared between the two groups through the independent sample *t*-test (see Table 1).

The results revealed that a significant difference was found between experimental (M =103.62, SD = 6.65) and control group (M =73.37, SD = 7.70), t = 1.69, $p < .05$, indicating that the hypothesis 1 (There is higher usage time on the learning system when students using the learning system with online learning community compared to those using the learning system individually) was accepted; in short, online learning community can enhance learning engagement.

Table 1
t test results of the system usage time for two groups

group	*n*	*M*	*SD*	*t*	*df*	*p*
experimental	28	103.62	6.05	1.69	60	.048*
control	34	73.37	7.70			

*$p < .05$.

3.2. Effect of online learning community on learning achievement

To examine whether online learning community can enhance learning achievement, ANCOVA was conducted. Mean scores and standard deviations was listed at Table 2, and the ANCOVA at Table 3. The results revealed that no significant difference was found between the experimental (M = 19.11, SD = 2.78) and the control group (M = 18.97, SD = 4.71), F = .03, p = .872, indicating that hypothesis 2 (There is higher learning achievement when students using the learning system with online learning community compared to those using the learning system individually) was rejected. Therefore, there was no statistical evidence to show online learning community can improve learning achievement.

Table 2
Pre- and Post-test Mean Scores and Standard Deviations for two groups

		Pretest		Posttest	
Group	*n*	*M*	*SD*	*M*	*SD*
Experimental	28	14.96	3.39	19.11	2.78
Control	34	14.97	4.06	18.97	4.71

Table 3
Analysis of Covariance of posttest for with and without online learning community groups with pretest as Covariate

Source	*SS*	*df*	*MS*	F	*p*
Covariate	264.8	1	264.8	23.08	
Between group	0.3	1	0.3	0.03	.872
Error	676.85	59	11.47		

3.3. Effect of peer interaction on learning engagement

Independent sample t test was used to analyze the effect of peer interaction on learning engagement (see Table 4). The results revealed that a significant difference was found between high peer interaction (M=161.38, SD= 44.66) and low peer interaction group (M=82.29, SD = 55.50), t = 3.21, $p < .05$, indicating that the hypothesis 3 (Students with higher online peer interaction have more usage time than those with lower online peer interaction) was accepted. That is, online peer interaction can enhance learning engagement.

Table 4
t test results of system using time for high and low interaction groups

group	*n*	*M*	*SD*	*t*	*df*	*p*
High interaction	8	161.38	44.66	3.21	15	$.00^{**}$
Low interaction	9	82.29	55.50			

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

3.4. Effect of peer interaction on learning achievement

An ANCOVA was also conducted to examine whether online peer interaction enhanced learning achievement. Mean scores and standard deviations was listed at Table 5, and the ANCOVA at Table 6. The results revealed that a significant difference was found between the experimental (M = 20.63, SD = 1.06) and the control group (M = 17.44, SD = 3.40), F = 6.55, p = .023, indicating that hypothesis 4 (Students with higher online peer interaction have higher learning achievement than those with lower online peer interaction) was accepted. In short, online peer interaction enhanced learning achievement.

Table 5
Mean Scores and Standard Deviations of Pretest and Posttest for Two Groups

		Pretest		posttest	
Group	*n*	*M*	*SD*	*M*	*SD*
High interaction	8	14.75	2.61	20.63	1.06
Low interaction	9	14.33	4.15	17.44	3.40

Table 6
Analysis of Covariance of Posttest for High and Low Peer Interaction Groups with Pretest as Covariate

	SS	*df*	*MS*	*F*	*p*
Covariate	15.67	1	15.67	2.6	
Between group	39.49	1	39.49	6.55	$.023^{*}$
Error	84.43	14	6.03		

$^{*}p < .05$.

4. Conclusion

Combining online communities with learning systems enables students to interact with peers, and is a growing trend in education. The present study demonstrated a potential approach for creating online communities in learning systems.

The results of this study indicated that learning communities can enhance students' learning engagement, but not their learning achievement. In addition, the results suggested that more peer interaction can lead to higher learning engagement and learning achievement. Therefore, learning communities can be an excellent means of providing peer interaction for online learning. In the future, researchers should apply this study to a K–12 learning context and various learning domains to facilitate improved learning.

Aknowledgement

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ACEiT
An Active and Collaborative Environment for in-class Teaching

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Abstract

In this paper we present a work-in-progress of development of a web-based system, ACEiT, designed to support in-class active and collaborative learning activities. Through the use of web and mobile interfaces the application aims to aid instructors in their multi-faceted role in a classroom to support students in collaboratively working together and facilitates peer learning through sharing of solutions. We report on the development of the application which aims to replace paper based active and collaborative learning activities along with provides analytics for better understanding of learning patterns of students.

Author Keywords
Active Learning; Collaborative Learning; Computer Supported Collaborative Learning;

1. Introduction

Over the past couple of decades, technology has played a major role in promoting active and collaborative learning within the classroom. Active learning involves the engagement of students and educators in the learning process through design, problem solving, decision-making, investigative activities, or reflections [1-7]. Collaborative learning involves joint intellectual effort by groups of students who are mutually searching for meanings, understanding, or solutions [8]. The fusion of these two pedagogies can be characterized as people working together on a learning exercise that encourages application, analysis, and synthesis of course topic(s) to solve or create something, and to meet certain learning objectives throughout the process. Evidence suggests that such pedagogies could be deployed effectively in promoting student learning in both small classes and larger ones; and can be used for courses originally designed as traditional lecture-based courses. [5,6]. Technology however doesn't replace the class activities; rather it complements them by directly addressing the curriculum and participating structures to enhance learning [1][4][7]. Technology aids the instructors in efficiently letting the students know what they are doing and how that is relevant to their learning. In addition, it provides a medium for the students to discuss and work together, which not only provides them with a wider exposure to peers' experiences but also helps them to be self-critical about the work they are doing and how it could be made more relevant to the context. An instructor plays 4 different roles [9] in the process of active and collaborative learning. These roles are:

- Pedagogical role: educating the students about the subject to be discussed and taught.
- Managerial role: administrative and procedural tasks required to facilitate the activities to be performed during the collaborative learning process.
- Social role: social aspects where the instructor tries to achieve oneness such that the cognitive learning process is not affected.
- Technical role: indulging in activities that are technology-based, in order to be prepared beforehand for the collaborative activity.

In this paper, we report the work-in-progress of development of ACEiT, an Active and Collaborative Environment for in-class Teaching, to support active and collaborative learning among students in a university course and to aid instructors in all of the above four roles. The objectives of ACEiT are (i) To allow instructor to create and manage active collaborative learning activities (Figure. 1) (ii) Support various types of questions for the activities (e.g. design-thinking, diagramming, descriptive writing, fill-in-the -blanks, Freehand sketching) (iii) facilitate students to think, pair or group and share work (Figure. 2) (iv) provide visualization of the responses submitted to aid understanding in learning patterns of the classroom (Figure. 3) (v) facilitate real-time notifications to students about the latest class activities (Figure. 4). These are achieved through design and implementation of a web-application for instructor, to create and manage activities, to give feedback to students and to analyze student responses, a web and a mobile-application for students to collaborate and respond to the learning activities (individually as well as in a group), submit their responses and view other students' responses and a robust cloud server to store, manipulate and retrieve data and provide synchronization mechanisms to the application.

2. Context

The landscape of technology that can be used to support active and collaborative learning is vast and varied. Many commercial tools as well as research lab tools are available that can facilitate real-time and asynchronous text, voice, and video communication; assist in basic group activities, like polling, discussions, task management, scheduling, planning, routing, and tracking; support co-creation of content by enabling groups to modify a common artifact in real-time or asynchronously; allows sharing, searching, tagging resources. Some of the research lab tools include quiz taking [10], real-time feedback to lecturer with regards to quality of lecture [11], sketching over slides [12], group learning through shared workspaces [13], collaborative note taking [14]. There are some free tools like Google Docs, Trello, Asana, Etherpad, that are commonly used for course work communications. Here we present a learning application that provides the following for in class interactions: (i) Instructor initiated learning activities during lecture, (ii) group submissions by students, (iii) sharing solutions among all, (iv) a rating mechanism by students, (iv) analytics e.g. how many students participated in an activity; how many activities attempted by each student etc.

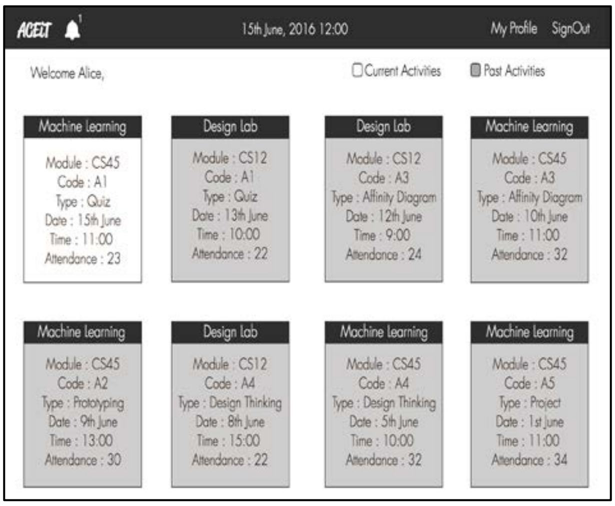

Figure 1: Landing page for instructor

ACEiT, conceptualized for in-class interactions among students and instructors in a highly interactive class, facilitates instructor-student and student-student interactions through web and mobile interfaces. Its setup is envisioned as a

(i) a web interface for instructors
(ii) a web interface for students
(iii) a mobile interface for the students for real-time notifications
(iv) an administrative utility
(v) provision for data persistence
(vi) analytics

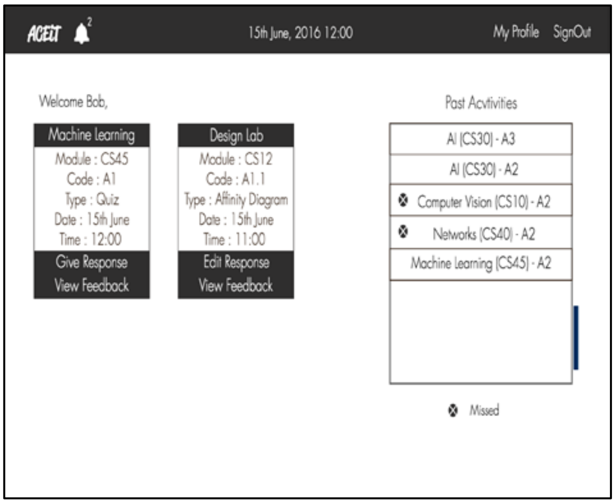

Figure 2: Landing page for student

We explain the system in context of its use in teaching of a course on human computer interaction. The lessons typically include in-class collaborative learning activities, known as Active Learning Exercises (ALEs), which facilitate e.g. Collaborative Ideation, Collaborative Storyboarding, and Collaborative Solution Analysis. Currently, these in-class activities are conducted in a traditional manner, without the significant involvement of any electronic medium. The instructor uses differently colored activity sheets to differentiate between the various ALEs. Subsequently, students form groups and then submit their respective team ALE sheets on which they have scribed their team responses so that the lecturer can keep a track of their attendance. Students then have to manage their activity sheets after the instructor returns them, in order for revision in future. Evidently, there is a lot of administrative inconvenience on both, instructor and student end.

ACEiT aims to enhance learning outcomes by (Figure. 5):

1. Reducing class time required for administration of activities (ALEs). As stated earlier, class time is spent collecting and distributing activity sheets. Since the instructor spends less time on such administrative activity and minimum time is required for explaining the activity (since the student can read the activity description when allowed access), more time is spent productively during lesson.

2. Enabling collation of students' responses for every

activity (ALE). A student can see the various responses by his/her peers and gauge how his/her own response can be improved.
3. Allowing easy review of peer responses. Instructor can now facilitate in-class critique over certain responses.
4. Enabling instructor to track student progress and understanding through viewing student responses.
5. Reducing paper consumption for collaborative activities. With ACEiT, the ALEs will be made available to registered students through a web interface.

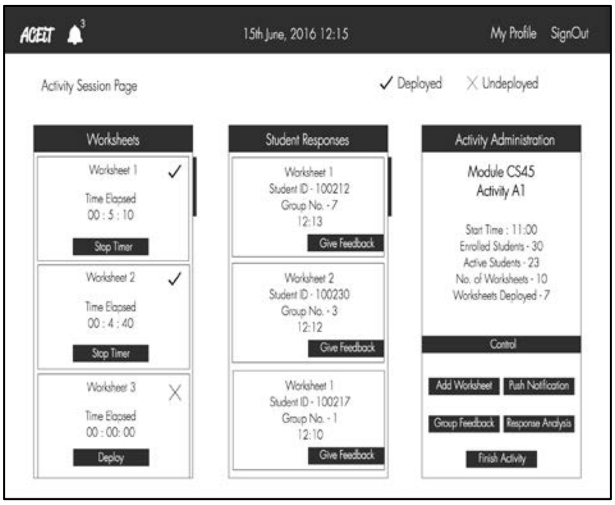

Figure 3: Activity session page for instructor

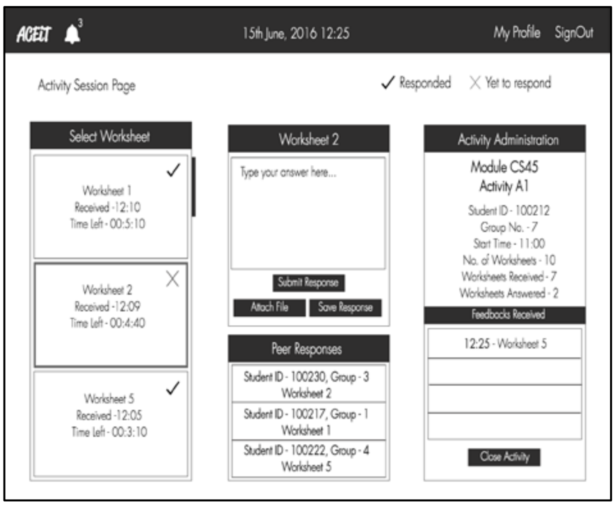

Figure 4: Activity session page for student

3. Prototype

Based on a contextual inquiry and participants/target group observation with an instructor and students of a Human Computer Interaction course, we have scoped the functionality and specifications of ACEiT to provide for the following features:

- An instructor is able to allow student access to particular ALE to enable collaboration/participation during the course of the lesson.
- Student responses are stored for future viewing by both instructor and students at any point during the course of the module.
- An instructor is able to view students' answers collectively for an activity (with each answer matched to a particular student identity).
- A student is able to view his/her peers' answers for a particular activity in a collated manner.
- A student is able to view his/her own collated answers for all the activities of any particular lesson.
- Both students and instructors should be able to access Interlace on web and mobile platforms.

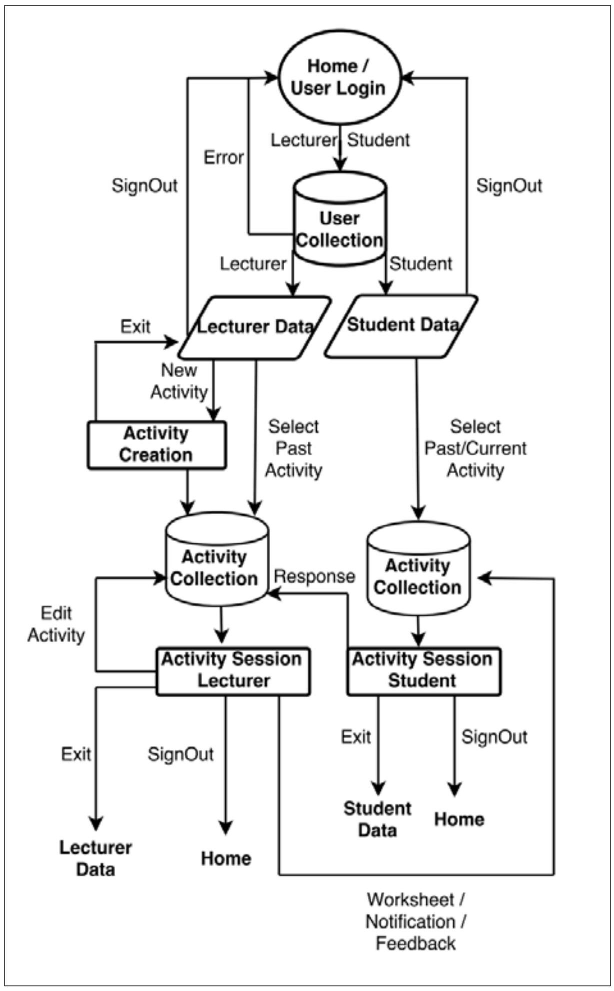

Figure 5: Application Flow Diagram

ACEiT is being built over Meteor, an open source development platform. Bootstrap is considered for enhancing responsiveness to the application. The user specific, app specific and activity specific data is stored in separate MongoDB instances (Figure. 6). For prototyping, the application is hosted on a cloud server that facilitates prototyping and testing. The server acts as the instructor portal (server in a client/server architecture). Separate instances of the application are run on multiple client devices in order to depict the students in a classroom scenario. The devices, hence serve as the student portals (clients). The students can log in to the application using their university credentials. An application session is then created for each login. The devices are connected to the server through a local network, same as the server's and hence a two-way communication channel is established.

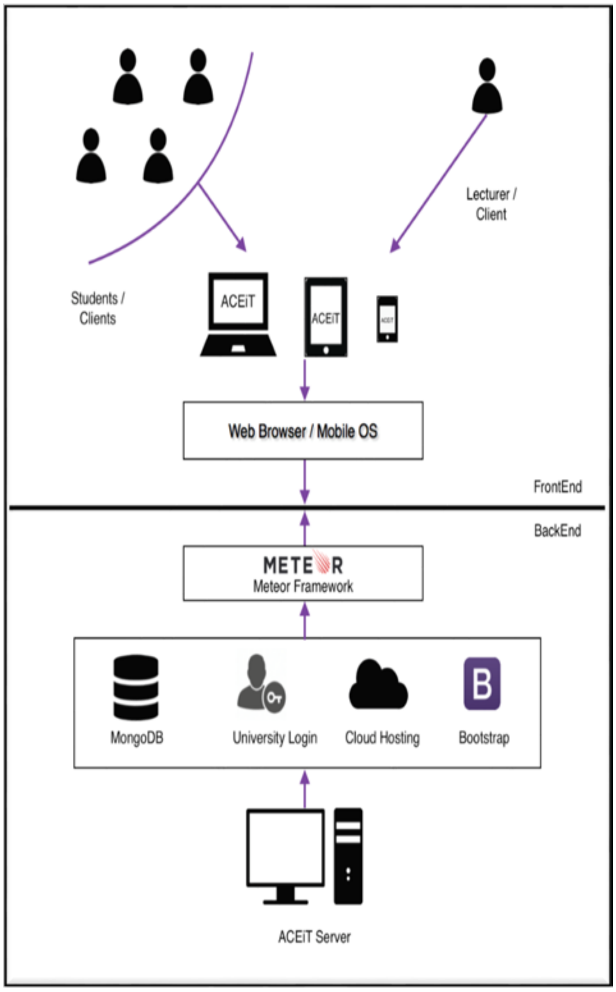

Figure 6: System Architecture

The application allows for the creation of different types of ALEs by the lecturer. The instructor sends the students notifications to their devices informing them about the newly uploaded ALEs. The students then select the ALE and can then view the ALE related content and can submit responses and receive the corresponding feedbacks. Both the response and the feedbacks are stored in student specific databases. The students also have the feature to view the responses of their peers, edit their earlier responses and re-submit responses. The server only stores the latest response. The lecturer has the ability to create ALEs on the fly, can deploy ALEs either in whole or per module, can see the student responses, can submit individual or group feedbacks and see the statistical analysis of student responses. It is to be noted that all communication and subsequent application updating occurs in real time. The above functionalities thus help in creating an in class active and collaborative learning environment to enhance instructor efficiency and student productivity.

4. Conclusions and Future Work

In this paper, we have reported work-in-progress of a tool being developed for conducting studio style courses which are effectively taught [15-18] with in-class active and collaborative learning pedagogies. However, the reach of this tool will not be limited to just studio style courses and its features could be used in any interactive classroom.

We believe that some of the most effective classroom solutions come from instructors and that working with educators closely throughout the formulation, design and evaluation of research and development is the surest way to make research and tools work in real classrooms. Currently, the design and prototyping of this tool uses contextual design methodology and participatory design approach with a single instructor and a few students of an HCI course. Next, the prototype will be evaluated in (i) a real-classroom of an HCI course with an instructor and 40 students (ii) with 1-3 instructors and 20-50 students of non-design courses through demo of the system followed by a survey or interview. The next iteration of the prototype will be based on the evaluation findings.

In addition, a research agenda is planned to create a better learning experience for students. The approach is to be as methodical as possible, taking one piece, implementing it and then measuring, and adjusting it. Learning science findings are not cut and dry. We are fundamentally boiling it down to measuring human interactions, in a methodical manner. Instructors have to synthesize them, in the context of the curriculum and classroom experiences, through small experiments to find out how far they can adapt the findings to achieve the set learning outcomes in their classrooms.

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Supporting Foreign Students' Job Search Process in Japan with SCROLL & AETEL

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Abstract

This paper describes the study where we aim to support foreign students' job hunting in Japan with our proposed career support system. Our previous evaluation revealed three issues to cope with in our SCROLL career support system. Reflecting its result, we have improved it by implementing EPUB-based eBook called AETEL. The evaluation of our new system was conducted. The 5-point-scale questionnaire result showed that the relog function gained the highest score. It also turned out that though overall usability of our system gained high score, AETEL itself had a problem in its usability. Our future work includes dealing with browser issues with the refinement of its contents

Keywords- Career support; E-book; Foreign students; Job-hunting; Learning log; mobile learning

1. Introduction

According to the survey conducted by JASSO (Japan Student Services Organization), 208,379 foreign students are studying in Japan as of May 1st, 2015 [1]. Japanese Government put forward a "Plan for 300,000 Exchange Students" since 2008 [2]. This plan is aiming for not only increasing the number of foreign students but also the number of foreign workers who keep staying in Japan after graduation. However, foreign students who would like to get jobs in Japan have been in a struggling situation [3]. Therefore, career support for foreign students has become an urgent issue to tackle with.

Job-hunting process in Japan is very peculiar. Students start job-hunting as early as when they are the third year students, more than 1 year before graduation. They start with writing CVs (curriculum vitae) and entry sheets, taking exams, written or web-based, such as general knowledge tests, aptitude tests, and personality tests, participating group discussion observed by recruiters, and getting group interviews and individual interviews at the final stage until they finally obtain an official job offer. It takes 8.9 months on average [4]. Japanese job-hunting process is so unique that most foreign students have anxieties about it.

The survey conducted in [5] revealed that the top two anxieties that foreign students had about job search in Japan were 1) language-related anxieties: writing CVs and entry sheets (writing skill) and job interviews (listening and speaking skills) and 2) anxiety about how to get information (Figure 1).

Figure 1. Anxiety factors about job search in Japan (excerpt from [5])

There are job-search related terms which even advanced Japanese language learners have not learned yet. Besides the survey result showed that more than half of the questionees selected "I don't know how to get information". It means that it is very important to convey necessary information to job-hunting students. In order to contribute to solving these problems, SCROLL Career Support System with AETEL has been developed.

2. Background

The progress of IT technologies such as multimedia technology, internet technology, and mobile technology provoked new learning strategies such as computer supported collaborative learning, web based learning, and mobile assisted learning [6][7][8].

Especially computer supported collaborative learning, as one of the means of active learning, has drawn much attention from not only researchers but from teachers/instructors [7]. By accessing resources of web sites, or by linking learners and numbers of learning contents, learning can be facilitated [8]. Its domains seem have no boundary, however no such learning system as foreign students' career support has been developed so far. The objective of this study is to propose an effective career support system to get rid of the two main anxieties of foreign students in Japan. Our ultimate goal is to contribute to the enhancement of their employment rate in Japan.

3. Career Support Using SCROLL and AETEL

3.1. SCROLL (Learning Log System)

Learning can happen anytime anywhere. Learning Log System called SCROLL (System for Capturing and Reminding of Learning Log) has been developed in order to support learners to record newly gained knowledges, to remind them, to share and reuse them [9]. SCROLL is a client-server application. The server side runs on Linux OS. It runs on different platforms such as smart phones, PCs, and tablets. It is designed to support every aspect of learners' learning activity model called LORE (Log-Organize-Recall-Evaluate) [9].

a) Logging

It facilitates the way learners record their newly learned terms to the server. For example, when a foreign student comes across a new term, "B2C" while he was reading job-search related contents on the web, he can upload it to the system with texts, images, video, or pdf files. Translation is facilitated by Google translator (Figure. 2).

Figure 2. Learning can happen anywhere and SCROLL supports logging

b) Organizing

If a learner learned a new knowledge, and uploaded it to the system, it checks if the same log or related logs wwew already uploaded or not and shows them as the related terms. Figure 3 shows the list of MyLogs for reviewing. He can search logs by name, location, tags and time. When he sees other learners' logs and find them useful, he can relog them to make them his own logs. Therefore, learners can obtain knowledge from others without having experienced it themselves. Using this function, the acquisition of knowledge is enhanced.

Figure 3. MyLog list

c) Recalling

Four types of quizzes (combination of image and text, multiple-choice and yes-no quiz) are generated automatically by the system. Figure. 4 shows interfaces of a multiple-choice image quiz and its result (up) and a multiple-choice text quiz and its result (down). These quizzes are generated according to the learner's profile, location, time and the results of the past quizzes they took.

Figure 4. SCROLL multiple-choice quiz and after-quiz interfaces (up: image quiz, down: text quiz)

d) Evaluating

Location information plays an important role in retaining memory [10]. Therefore TimeMap developed by [11] was implemented so that learners can review and evaluate their learning by viewing it (Figure 5). SCROLL top page includes a dashboard which shows the statistics of learners' activities (Figure 6).

Figure 5. SCROLL TimeMap

Figure 6. SCROLL Dashboard

3.2. AETEL

The evaluation conducted in [5] revealed that 1) “Relog” button was unclear and hard to find, 2) Important information was buried and hard to find, and 3) The contents were too easy to some users who already had some job-hunting experiences. As for 1), “relog” icon has been renewed so now anyone can easily find it. In order to solve 2) and 3), we have added a new function called AETEL to SCROLL and proposed the following system.

a) AETEL EPUB-viewer

AETEL (Actions and learning on E-TExtbook Logging) is an additional system implemented to SCROLL. It runs inside SCROLL. It consists of database and EPUB files. Figure 7 shows its architecture. EPUB-viewer is a main function of AETEL. This function shows e-Book contents to viewers, record learners’ actions as action logs, and record what learners learned from e-Book as learning logs. On EPUB-viewer, learners can take various actions, such as page turning, page jumping, bookmarking, highlighting, adding logs, taking memos, looking into the web dictionary and searching by keywords (Figure 8).

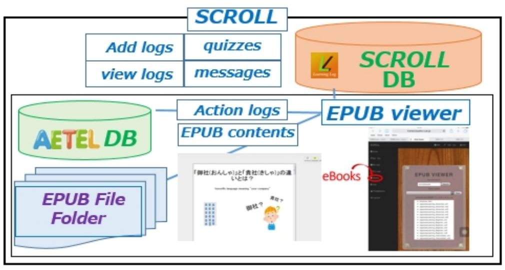

Figure 7. Architecture

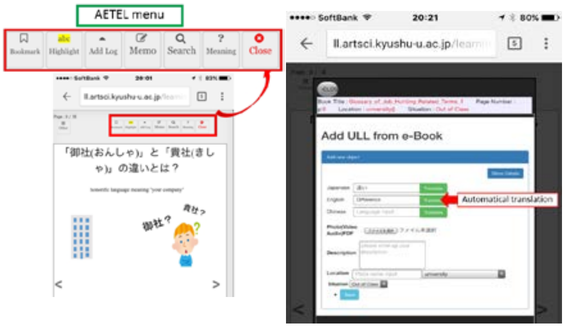

Figure 8. AETEL EPUB-viewer: Viewer window (left) and Add ULL window (right)

3.3. SCROLL Career Support

The objective of this system is 1) to share job-hunting related information among job-hunters, 2) to organize and reinforce their knowledge. Figure 9 shows its learning process.

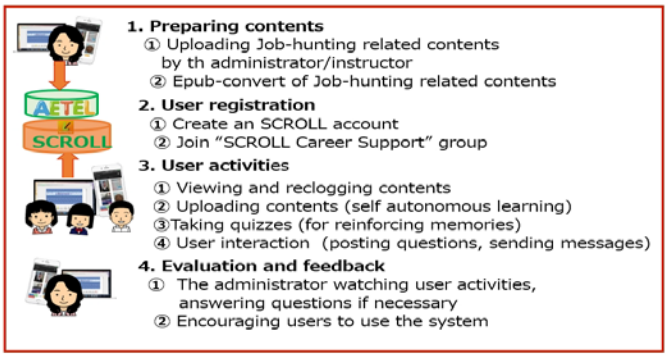

Figure 9. SCROLL career support: Learning scenario

4. Pilot Evaluation

Since AETEL is our new addition to SCROLL, the main objective of this evaluation was to have learners to use AETEL and evaluate it. Most SCROLL functions explained above were not targeted in our evaluation except relog function, since we improved the relog button after the previous evaluation and encouraged them to use it. Seven foreign students (5 Chinese, 1 Angolan, 1 Iranian/ 4 males, 3 females/ 4 M1s, 1 M2, 1 D1, 1 D3) who study at university in the west part of Japan participated in the evaluation. They had mainly two tasks:(1) SCROLL activities: i) view log information such as how to write ES, job hunting flow in Japan, how to continue job hunting after graduation, and job fair information, ii) upload newly learned words, iii) relogging useful logs, (2) AETEL activities: i) view contents, ii) learn some job-hunting related terms such as B to B, B to C, difference between 内定 (official job offer) and 内々定 (early official job offer), difference between 御社 and 貴社 (both mean honorific language meaning ‘your company but used differently). After using this system for a designated period of time (from one day to two weeks), they were asked to answer the questionnaire as shown in Table I.

Table 1. The result of five-point-scale questionnaire

	Question	Mean	SD
Q1	Was it easy for you to use SCROLL?	4.1	1.3
Q2	Was the whole system helpful for you to get career related information	4.3	0.7
Q3	Did the relog function facilitate your learning	4.6	0.5
Q4	Was **AETEL** helpful for you to get career related information?	3.3	1.2

The result of the five-point-scale questionnaire is shown in Table 1. According to the survey result shown in Figure 1 in Section 1, more than half had an anxiety that they don't know how to get information. Since they scored high on Q2, we believe our system contributed to conveyance of information. The highest point was given to Q3 asking about usefulness of its relog function. Relog function made them share knowledge quite easily, and they seemed enjoying it as shown in the comment #2 in Table 2. Its easiness of sharing would be the contributor to its highest score. Unlike our expectation, AETEL function was rated the lowest. The reason seems to be its user unfriendliness as mentioned in the next paragraph.

Table 2 shows comments from the participants. The first two comments were very positive ones. To let them get familiar with business Japanese language is one of our main objectives. However the third commentator seemed to have had some difficulties in using it. In fact mobile Safari does not support AETEL. The recommended browser is CHROME and they were instructed to use it. Since the average overall usability was as good as 4.1, most participants found it easy to use. However making it run in any kind of browsers is among our future works.

Table 2. Your impression on using Scroll Career Support with AETEL

	Comments
Comment #1	It mostly helped me get familiar with business Japanese vocabulary.
Comment #2	It was good to share knowledge with other learners.
Comment #3	It seems to be a great idea but, I cannot explain why I had difficulties to use it (not sure if it depends on the type of OS, browser, etc). So, I think a regular updates could be a good advance.

5. Conclusions and future works

A pilot evaluation revealed that the system had a high usability and most users were satisfied with using it. Its relogging interface was improved and it helped users share job-hunting related knowledge. The system is expected to play an important role as information supplier. However, there was a user who had a difficulty in using it and our future works include dealing with browser issues.

With the refinement of AETEL contents, more detail examination of effectiveness of our system will be conducted. We believe that our system will contribute to the increase of employment rate of international students in Japan.

Acknowledgments

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Dynamic Groups for Digital Content for Collaborative Learning

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Abstract

This paper presents a module for dynamic grouping designed to be used as part of digital educational lessons. Dynamic groups can be generated ad hoc, depending on the educational settings and the designed lessons. The students are dynamically grouped via several algorithms and a number of parameters preconfigured by teachers. This kind of an approach is used to make digital contents of any kind collaborative, as long as it confirms to the basic specification of the system interfaces. It is means of achieving collaboration-based classroom experiences, which tend to be more dynamic and engaging for the students. The paper presents the existing SCOLLAm platform and the dynamic grouping mechanisms used within.

1. Introduction

SCOLLAm project ("Opening up education through Seamless and COLLAborative Mobile learning on tablet computers") is one of the first scientific research projects closely related to mobile learning that is implemented in Croatian schools. SCOLLAm is building up on the experience of team members and in similar projects from Sweden, USA, and especially the Seamless learning project conducted by the National Institute of Education in Singapore [1]. The main goals of the project are: proposal and design of a technologically innovative, scalable and durable mobile learning platform, cooperation with teachers in order to ensure an adequate teacher development and their competences in the ICT and mobile technologies fields, and creation of digital content tailored for usage in the first years of primary school.

There are two main parts of the system designed as part of the SCOLLAm project: a mobile learning platform named SCOLLAm [in]Form, and a designer and player of digital lessons – SCOLLAm Author. The core central system components include collaborative learning, augmented reality, analytics and adaptivity modules.

In this paper the special attention will be given to the collaboration components of the system which include static grouping and dynamic grouping of students to be engaged in a diverse set of collaborative educational activities. The paper will attempt to answer these two research questions:

(1) What are the mechanisms to be used in synchronous in-class collaboration around digital content and
(2) How can *ad hoc* group formation for in-class collaboration be supported by the system

The rest of this paper is organized as follows: in section 2 the theory behind dynamic grouping in collaborative learning in presented. The mechanisms for authoring digital collaboration content in the SCOLLAm platform is presented in section 3. Usage of collaboration and dynamic grouping in digital lessons is laid out in sections 4 and 5. Finally, Section 6 concludes the paper.

2. Dynamic group formation in collaborative learning

There are several reasons for adapting content to learners such as different level of prior knowledge and skills among individuals, sociocultural and demographic differences, different abilities or disabilities and student's affective state such as frustration, motivation, confidence etc. [2]. Adaptive instruction [3], [4] can be designed using one or more approaches based on macro and micro level [4]. The papers reporting on the use of adaptive mechanisms in collaborative and cooperative activities are:

1) An educational reality-based virtual environment called EVE [5] which supports cooperation among members through avatars. Based on communication techniques of knowledge and skills, typically used in intelligent tutoring systems, the EVE system is able to adapt the level of the knowledge representation to the children.

2) An intelligent argumentation assessment system based on machine learning techniques for computer supported cooperative learning [6] uses feedback rule construction mechanism to issue feedback messages to the learners in case it detects unwanted learning behaviour of a single user. As a result the student is provided a hint or suggestion. This system is also able to determine the argumentation skill level based on a student's argument.

3) A constructivist computational platform [7] constructed out of a student model, a domain model and an interactive model. They are all used for content adaptation based on user knowledge.

3. Authoring digital collaboration content in the SCOLLAm platform

3.1. The SCOLLAm Author system

The SCOLLAm Author system is a web application for designing and reproducing interactive lessons. Each lesson is a package that may contain multimedia elements such as text, image, shapes, widgets and others. There is also an option of defining interactive rules that trigger an action based on some interaction. Some examples of user defined triggers can be object move, object touch, object drag and drop that can make some other object change position, style or size. Using these simple concepts, a variety of interactive lessons can be created which would allow for easier usability (Figure 1).

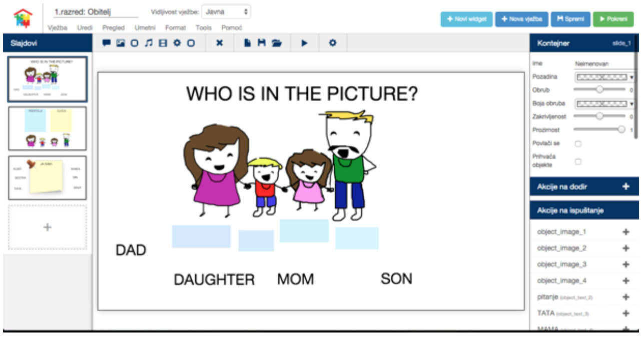
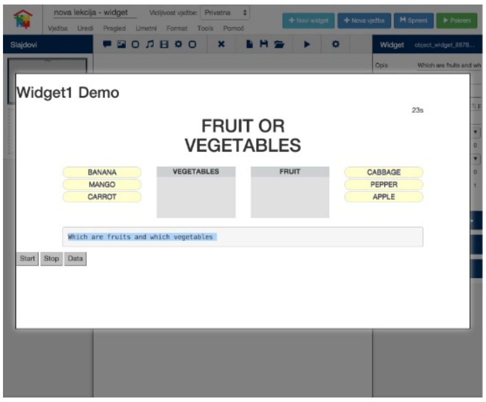


Figure 1: Author learning system - editor component

3.2. Collaborative widgets

To support a wide-array of interactive learning scenarios, the SCOLLAm Author system allows for import of simple web modules containing educational applications. A module is developed as a stand-alone web application and is integrated in the Author system through an HTML5 iframe. Example of such a standalone third-party (independently developed) module is given in Figure 2.



Figures 2: A third-party interactive learning module after it is imported into the Author system – the preview mode

Every widget can be turned into a collaborative widget by feeding it with the adequate parameters. Whenever a widget is used as part of lesson, the parameters will be utilized and the widget will be specialized for the current use. There is a variety of possible parameters to be set (please refer to the right side of Figure 1), but only some of them are tied to the collaborative functions (Figure 3).

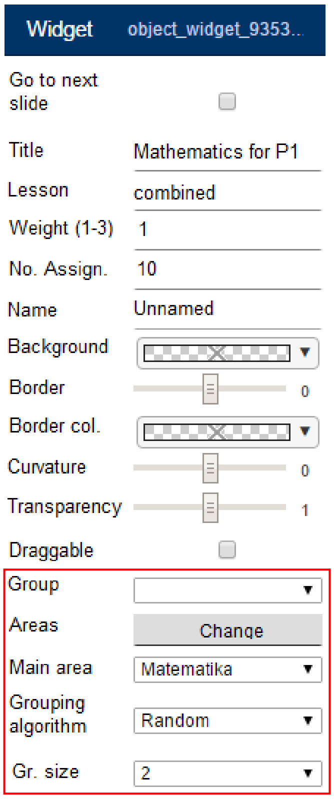


Figure 3. Widget parameters (generic ones in to upper part; collaboration-specific in the bottom in red box)

The parameters in the bottom part of the parameters panel (Figure 3) specify how groups can be created and/or associated with a specific widget. If selected, the *Group* field fixes collaboration group for the specific widget

operation. *Areas* specify content areas to which widget should relate when adapting to users' prior knowledge, while the *Main area* is used to solely classify the widget topic content. *Grouping algorithm* is used if ad hoc grouping is to be used (in that case *Group* will not be used for fixed grouping), where the *Gr. size* parameter determines how big the subgroup created by the algorithm will be.
Determined by the lesson designer, groups are used only if the collaboration parameters of a specific widget are set on a widget instance within a lesson. This is not mandatory and lesson designers (i.e. teachers) can set them only if they are designing a collaborative lesson. Once a widget instance is launched by students/users ad hoc groups will be momentarily generated and the system will continue its operation in the collaboration mode.

4. Designing digital collaborative lessons with dynamic grouping

In the SCOLLAm Author system, the design of a digital lesson includes deciding on the main building parts of the lesson, so called slides. Slides are visual components shown to as one scene on a computer/tablet/smartphone screen. Students choose to advance to the next or previous slide depending on the learning trajectory chosen or on the lesson design employed by the teacher (Figure 4).

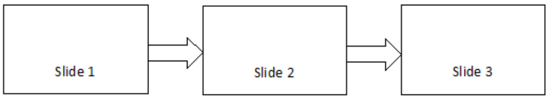


Figure 4. A digital lesson composed of three slides sequenced one after another

Widgets, on the other hand, are reusable components that exist in a variety of instances across the slides of one or more lessons. The context is of great importance when it comes to widgets as they get adapted or adjusted according to different use scenarios. For example, in once context, a widget can leverage one set of ad hoc groups (i.e. pairs), while in the other context it can operate in completely different ad hoc group context (i.e. triads) (Figure 5).

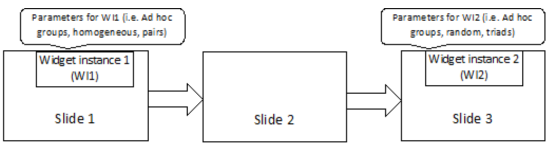


Figure 5. A digital lesson of three slides with two instances of the same widget (WI1 and WI2) operating under different contexts.

5. Using dynamic groups in a mathematics lesson

In order to trial out the system a simple trial run in one class was designed in June 2016. It was P1 class of 19 students and the task was to work in groups to solve a sequence of simple mathematical tasks in the content area of addition (e.g. 10 + 5 = ?). The digital lesson parameters were:

- Math widget was used
- Ad hoc grouping was used
- Random grouping algorithm was employed
- Ad hoc groups were of size 2 (pairs)
- The widget was designed to support the roles of recorder and checker

The system was trialed in an existing classroom as part of the Mathematics lesson (Figure 6).

Figure 6. A child using the Mathematics widgets in an ad hoc collaborative group context.

6. Conclusion and references

This paper presented the SCOLLAm projects and the tools developed as part of the project: SCOLLAm [in]Form and SCOLLAm Author. The tools can be used to support a variety of learning scenarios relying on digital lessons. Lesson designers can distribute the learning contents to students who then consume it on their tablets or smartphones, independent of the operating system (platforms) of their devices.
This paper tackled the use of collaborative learning in such a complex system where users can be grouped in fixed groups or take part in more emergent ad hoc collaborative activities. Since the digital content is organized around slides composed of widgets, lesson designers can leverage the context of use to parametrize collaborative learning experiences.
A trial run had been completed to demonstrate the use of the system whereby the following issues and challenges were identified:

- Synchronous collaborative learning scenarios require more advance synchronization mechanisms since users tend to drop out and return back to the lesson in a group work more

- Teachers need more overview and tools to maintain the structure of the lesson
- Adaptivity is of great importance to maintain the attention of both underachievers and overachievers.

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