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The Effect of Employing AR Interactive Approach on Students' English Preposition Learning Performance

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ABSTRACT. *The learning of English prepositions of place is an abstract learning mode for non-English beginners. To address the issue, in this study, a Mobile Augmented Reality English Learning App (MARELA) was developed on the basis of augmented reality (AR) technology to create a more efficient and interesting interactive learning. The MARELA would assist students on English learning. The course content was based on English prepositions of place with multimedia formats including text, voice, graphic, movie and interaction. This paper examined students' learning motivation and acceptance of MARELA after experiment. The results indicate the students highly recognized the ease-of-use and usefulness of the mobile AR English learning app. However, the results show an interesting way to promote English prepositions of place via augmented reality learning environment. The augmented reality English learning was novel and interesting for students learning.*

Keywords: *Augmented reality, AR book, English learning, mobile augmented reality, learning achievement*

1. Introduction

English is an international language and one of the most important languages worldwide. It serves as the global language of communication especially when people communicate with foreigners in social or international occasions all over the world. Because of globalization, there are more opportunities for people to use English.

Many researchers have developed various teaching and learning systems in education. Multimedia teaching and learning environments have offered various educational resources for teachers and learners to interact with (Asai, Kobayashi, & Kondo, 2005). Hsu, Hwang, Chang, and Chang (2013) investigated the effects of different display modes of video captions on handheld devices. The results showed learning effectiveness was significant on vocabulary acquisition. Cheng, Hwang, Uw, Shadiev and Xie (2010) proposed a mobile device and online system, StudentPartner, to help students learn English on campus using multimedia and GPS support. Therefore, many computer assisted instruction (CAI) softwares and tools are applied in teaching and learning (Hsieh, Wang, Chao & Lin, 2013; Al-Mansour & Al-Shorman, 2012; Hsieh, Lin, Lin, Ou & Chen, 2012). The Horizon Report indicates that technologies will be gradually adopted into education in the next two to three years. For example, there are technologies such as e-Book, Augmented Reality (AR), Mobile Apps, Tablet Computing, Game-based Learning, Learning Analytics, Gesture-based Computing, Internet of Tings. The Augmented Reality is one of them (Johnson, Smith, Willis, Levine, & Haywood, 2011). Scholars have mentioned the virtual reality and mixed reality have been proposed as a technological breakthrough that holds the power to facilitate learning (Pan, Cheok, Yang, Zhu, & Shi, 2006). The virtual reality and mixed reality technology in education have enriched teaching and learning in current educational strategy.

Billinghurst, Mark, Belcher, Gupta, and Kiyokawa (2003) have pointed out that using AR as a teaching aid could help interaction between teachers and students. Moreover, it has formed a new teaching strategy, with the help of which, teachers or learners can operate without any experience in computer usage. The augmented reality was not referred until 2010 Horizon Report (Johnson, Laurence, Levine, Smith, & Stone, 2010), in which mobile devices were again forecasted to play an important role in education; these technologies are now predicted to take effect in the mid-term. Martin et al. (2011) indicated AR technologies are most likely to have an impact on education according to the Horizon Reports from 2004 to 2010. Nonetheless, it is noteworthy that the applications of AR in Education are still few (Andújar, Mejías, & Márquez, 2011). As the above-mentioned review, it is crucial to improve the English learning approach via augmented reality learning app construction.

2. Literature Review

2.1 Augmented Reality

Augmented Reality (AR) is an advance of Virtual Reality (VR) (Azuma, 1997). It allows virtual imagery to be seamlessly overlaid onto views of the real world (Billinghurst, 2011). AR is an advanced technology that merges elements of a physical real world environment with virtual computer-generated imagery such as images, 3D objects or scenes (Milgram & Kishino, 1994). In sum, it adds virtual objects to real world environment. Azuma (1997) defines that the applications of AR must have three characteristics: the combination of real and virtual objects in a real environment, real time interaction, and the virtual objects registered in 3D.

The technique of augmented reality marker recognition can be mainly divided into two forms, marker-based and markerless-based AR to register digital content for real world orientation and placement (Specht et al., 2011). Specht, Ternier, and Greller (2011) indicated augmented reality applications to smart phones enabled new and mobile AR experiences for users. With the widely use of smart phones, AR is set to become a ubiquitous commodity for mobile learning.

2.2 Augmented Reality in Education

AR has been applied in researches on English learning. For example, Kirner and Zorzal (2005) developed an English letter spelling game. As for its rule, players had to pick up the right cards to spell the correct vocabulary in the AR English letter cards. If their spelling was right, a virtual object of the English letter card came out on the monitor. In such an attractive situation, the game could encourage players to interact more actively and fortify their problem-solving ability. Liu et al. (2007) constructed a 2D barcode and handheld augmented reality supported learning system called HELLO (Handheld English Language Learning Organization) to improve students' English ability. The HELLO integrated the 2D barcodes, the Internet, augmented reality, mobile computing and database technologies. This study indicated that 2D barcodes and augmented reality technology were useful for English learning. Chang et al. (2011) implemented an AR learning system for English vocabulary learning. They investigated learners' satisfaction and behavioral intention as well as the achievement of the AR-learning system. This study shows that system quality was a critical factor affecting perceived satisfaction, perceived usefulness, and AR-learning achievement. Furthermore, the design of system function and operation process must be more straightforward for learners when adopting new technology in the learning system. Yang et al. (2010) designed and developed a Physically Interactive Learning Environment (PILE) system by integrating video-capture virtual reality technology into a classroom. This system was designed to help elementary students for English learning interacting with physical movements with the system. Their research results gained from the teacher's interview illustrated that the teacher believed this system was beneficial to students in English learning. All findings collectively demonstrate that the proposed PILE system effectively assisted English learning in a

classroom.

3. System Development

The purpose of this paper was to develop a Mobile Augmented Reality English Learning App (MARELA) that assist students in English learning by themselves. The system development of MARELA was based on Android SDK for Eclipse and supported by Vuforia AR SDK. The Vuforia AR SDK enabled the creation of AR applications for mobile devices and employed with Computer Vision technology to recognize and track images (i.e. picture, photo) as well as simple 3D objects (like boxes). The application used live camera preview images on the display to present a view of the real world. Virtual 3D objects are then superimposed on the live camera preview and they appear to be tightly coupled (i.e. registered) in the real world (Qualcomm, 2012). The built 3D Digital Content Materials and 3D avatar (Swensen, 2012) based on lesson 7 contents after discussing with junior high school English teacher.

The following is the development of MARELA processing procedure. (1) Designing Markerless pattern: designing pictures (or photo) as the AR Markerless pattern in order to recognize MARELA. (2) Creating trackable: creating recognition feature trackable, used for system recognition and tracking. (3) Designing Materials: designing and modeling the learning content, including 3D model design, learning content, picture, and video materials in 3DS Max. (4) Exporting Object file (.obj): exporting object files after modeled from 3DS Max. (5) Converting .obj to .h: using Perl to convert obj 3D models to arrays compatible with android OpenGL ES. (6) Programming OpenGL ES: programming OpenGL ES for model rendering. (7) Building Android NDK: using Cygwin Terminal to generate libQCAR.so. (8) Publishing Application: publishing application and generating Android Package (apk).

Figure 1 shows MARELA operation mode. Using the system first time, the student held smart phones and executed QR code scanner in their smart phones. After that, the built-in camera aimed at the QR code and decrypted the internal code. Then, the smart phone downloaded MARELA and started installation. However, the student had to execute the MARELA manually. Next, the built-in camera in their smart phones would trigger a video stream. The student targeted the built-in camera at the picture and captured it. The MARELA detected images. Finally, the learning content would be superimposed on picture and it displayed on smart phone screen.

Figure 2 is course unit menu that students can choose which unit they want to learn. Figure 3 is readme screen. The students can read it and understand how to use MARELA when students use it for the first time. Figure 4 shows AR learning material contents display screen. On the screen appear the 3D avatar, AR learning material contents and three interactive buttons “Exit”, “Back”, and “Sounds”. Pressing “Exit” can close App; pressing “Back” can go back to the course unit menu; and pressing “Sounds” could play the sounds of the learning contents.

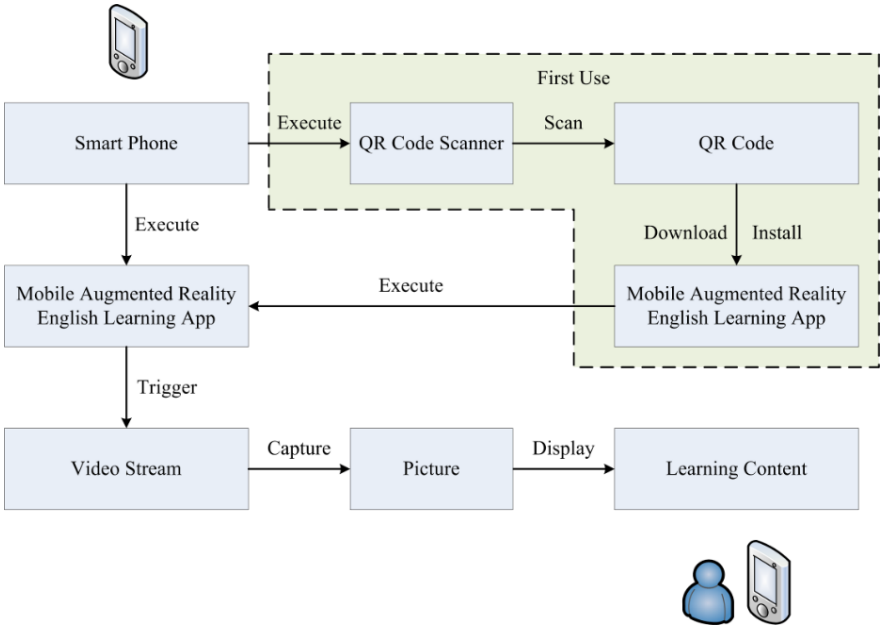


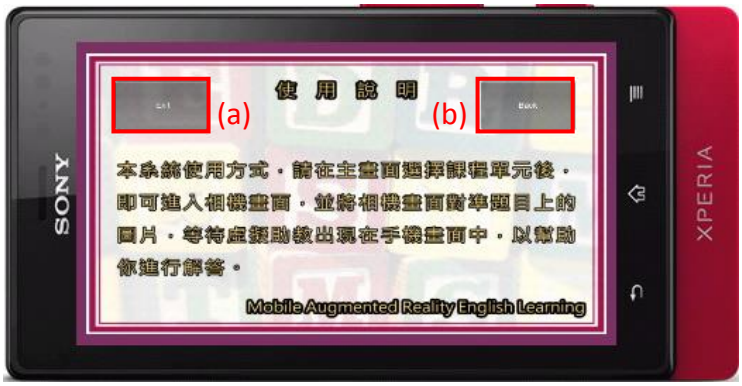
Figure 1. Operation flowchart of MARELA with QR Code

(a) Exit button

(b) Readme button

(c) Lesson unit selection buttons

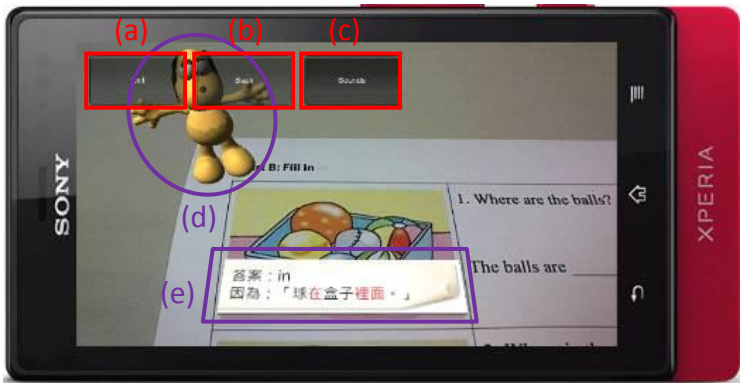
Figure 2. Units selection of MARELA



(a) Exit button

(b) Back button

Figure 3. "Readme" instruction of MARELA



(a) Exit button

(b) Backward button

(c) Sounds button

(d) Avatar (virtual teaching assistant)

(e) Instructions

Figure 4. Learning material contents on MARELA

4. Experiment

4.1 Participants

The participants in MARELA experiment were seventh-grade students from 6 classes at a junior high school in Southern Taiwan. A total of 106 students participated in the experiment. One week before the experiment, the teacher asked students whether they possessed smart phones, and allowed them to bring their own mobile phones to school. As for their parents, they also permitted their children to bring smart phones to school by signing on an agreement. Speaking of the location, this experiment was implemented in the computer classroom. In the following week of computer class, the MARELA experiment was administered. The MARELA experiment was conducted with three weeks with one class per week.

4.2 Procedure

In the first class, the English teacher introduced why they did this experiment, how important this experiment was, and how to use the MARELA. After that, the participants filled in the worksheets based on “the Book 1 - Lesson 7: Where Are My Shoes?” from Kang Hsuan Educational Publishing Group. The three-page worksheet was designed by the English teacher. The subtitle of Part A is "Look and Write", the Part B is "Fill In", and Part C is "Circle It", shown on the Figure 5 In the second class, the students pre-set up their smart phones in the computer

classroom where the wireless network had been ready. The pre-setup included linking wireless network, downloading the QR code scanner, installing QR code scanner, using QR code scanner, scanning the QR code on worksheet, and installing MARELA apps.

After pre-setup stage, the students used MARELA instructional material. The smart phone screen showed the avatar, answer, and further explanation for the answer.

The students operated the MARELA procedures according to the task assigned to complete the entire experiment in Figure 6. Figure 7 shows students operated the MARELA. It included four pictures, the monitor of the smart phone showed the AR 3D digital materials. The student also operated the MARELA with a Tablet PC (Pad). The students concentrated on learning AR English materials.

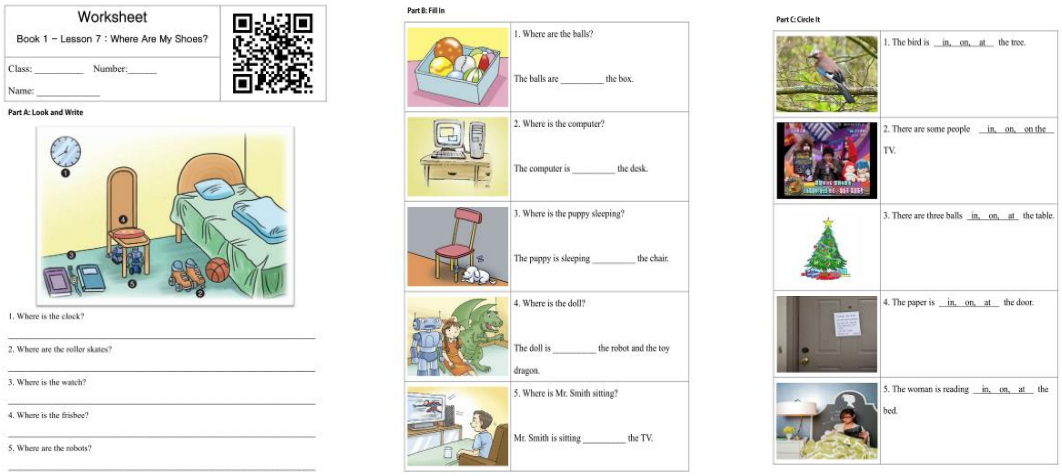


Figure 5. The worksheet "Where Are My Shoes?"

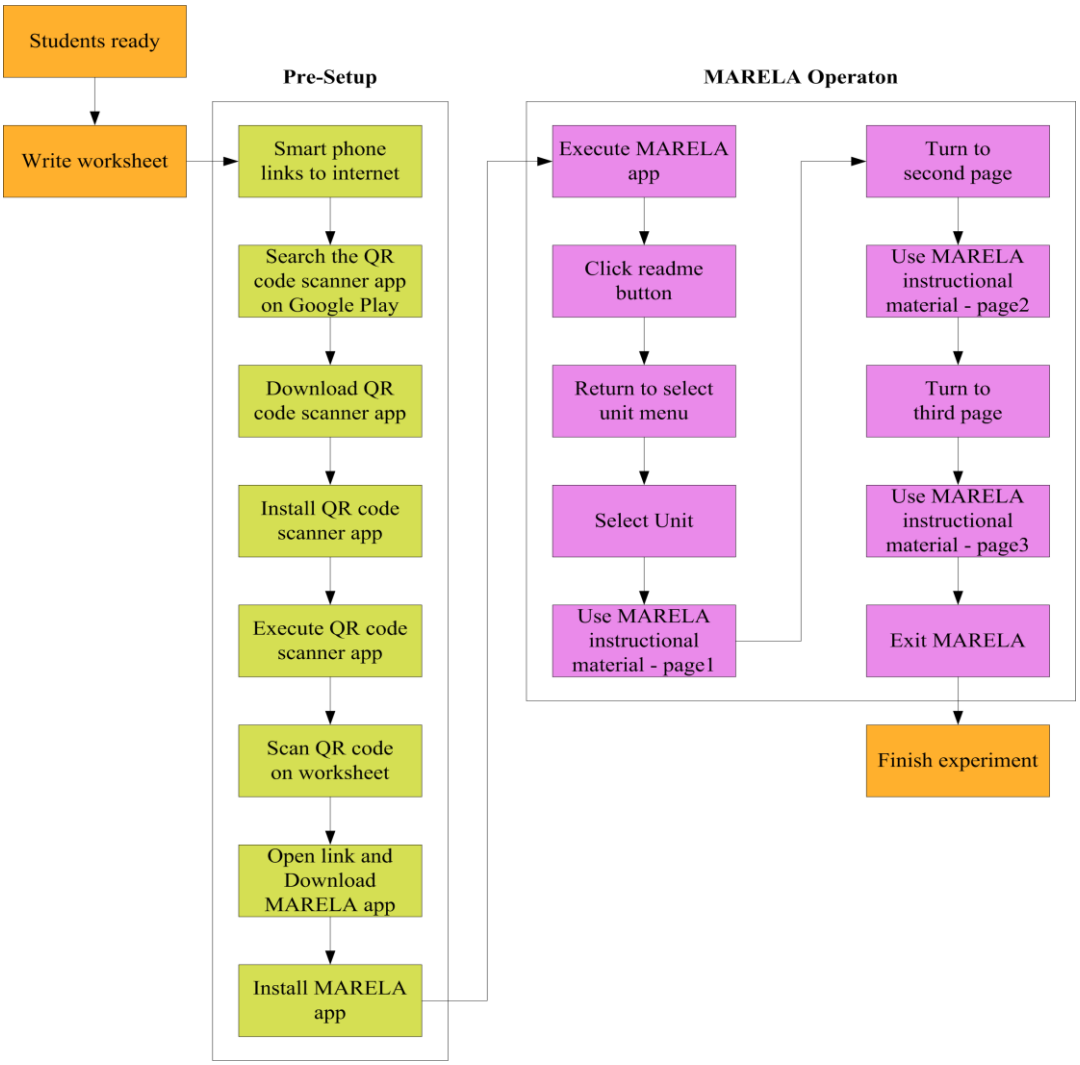
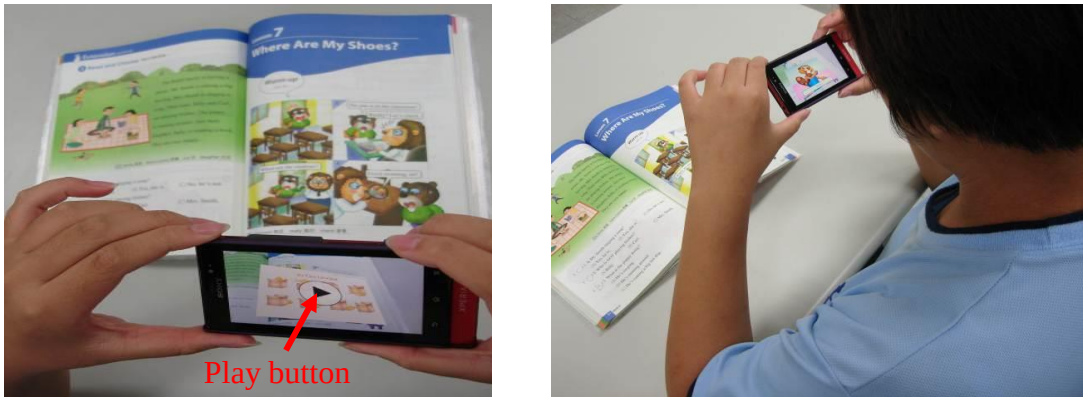


Figure 6. The task assignment of MARELA operation for students

Figure 7 Students operated the MARELA

Besides the part of worksheets, the students could review the contents taught by the English teacher in the school, and execute the MARELA at home with a smart phone. The built-in camera in smart phone would trigger a video stream through aiming at the targeted learning

picture of the English textbook. Accordingly, the video of learning contents would be superimposed on English textbook and display on smart phone screen, shown on the Figure 8 (a). The video clip would play learning contents when the student clicked “play button”. The Figure 8 (b) shows a student was aiming at a picture so that the screen displayed learning video and contents.



(a) (b)

Figure 8 A student was learning by MARELA and English textbook

After MARELA experiment being finished, the English teacher immediately administered two questionnaires to the students, instructional materials and motivation survey (IMMS), and acceptance questionnaire. The former measurement is used to evaluate motivation of the students, and the later measurement is used to evaluate the acceptance of the mobile AR English learning app. The questionnaire was done by students after they finished using MARELA instructional material in the third class. The Figure 9 shows the experiment procedure of MARELA.

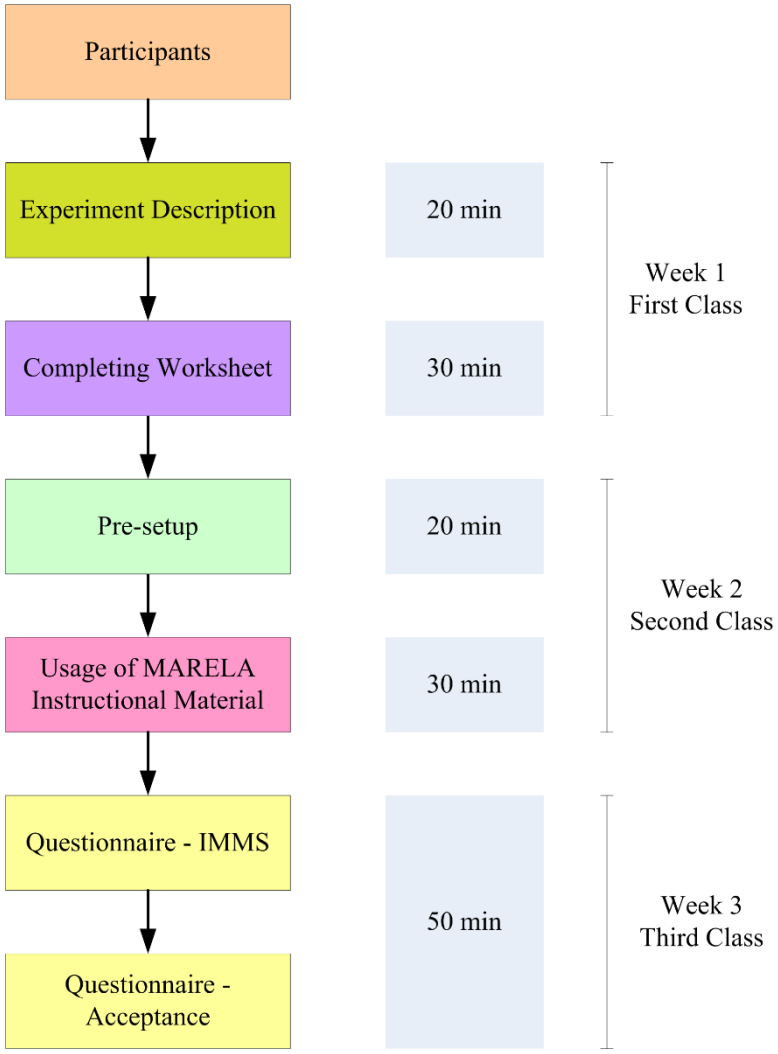


Figure 9. The experiment procedure of the study

4.3 Instruments

The Instructional Materials Motivation Survey (IMMS) was used to evaluate students' motivation. The IMMS was slightly modified for the AR field of this research. IMMS consisted of 36 items with five-point Likert scale, which 1 represented "strongly disagree", and 5 for "strongly agree". This motivational measurement instrument was based on ARCS motivation model (Keller, 1987a, 1987b). The IMMS included four elements, Attention, Relevance, Confidence, and Satisfaction. The Cronbach's α (reliability) value for each ARCS element were .89, .81, .90, and .96 respectively. The total Scale Cronbach's α was 0.96 (Keller, 2010) and it was administered in related researches (Bolliger et al., 2010; Di Serio et al., 2012; Rodgers & Withrow-Thorton, 2005). For experimental participants in related research (Di Serio et al., 2012), they were secondary school students, the age ranged from 13 to16. Hence, the participants used in IMMS were applicable in this research.

This study conducted a survey to understand students' attitudes in MARELA acceptance.

The perceived usefulness and perceived ease of use questionnaire were used to collect the students' attitudes toward using MARELA. The questionnaire was based on these studies (Chu, Hwang, & Tsai, 2010; Davis, 1989; Wu, Hwang, Tsai, Chen, & Huang, 2011). The questionnaire used in this research consisted of 13 items with five-point Likert scale, where 1 represented "strongly disagree" and 5 signified "strongly agree". The Cronbach's α of the entire questionnaire was 0.87., indicating sufficient internal consistency for assessing the students' acceptance of using MARELA (Cohen, 1988). All the questionnaires were reviewed by two experts to ensure content validity. The backgrounds and specialties of the experts are listed in Table 1.

Table 1. The backgrounds and specialties of the experts

Expert	Specialty	Background
A	Augmented Reality, Digital Content	Computer Sciences
B	E-learning, Digital Content	Educational Technology

5. Results

In the analysis of the motivation of the Mobile AR English Learning App, Table 2 was the descriptive statistics of IMMS. There are four dimensions in the scale. Each dimension consists of nine items, and scoring 45 maximun. The mean of Satisfaction dimension was the highest. The mean of the Attention, Relevance, and Confidence all scored more than 34, indicating the students had a strong enthusiasm for mobile AR English learning material. After experiment, the reliability Cronbach's α value was 0.95.

Table 2. Descriptive statistics of IMMS

Dimensions	N	Mean	SD
Attention	106	34.61	5.621
Relevance	106	34.25	5.368
Confidence	106	34.86	5.632
Satisfaction	106	35.21	5.393

In the analysis of the acceptance of the Mobile AR English Learning App, there were two dimensions in acceptance questionnaire. One was the Perceived Usefulness (PU) the other was

the Perceived Ease-of-Use (PEU). The perceived usefulness (PU) items were from Q1 to Q6 and the perceived ease-of-use (PEU) items were from Q7 to Q13, respectively.

Table 3 The descriptive statistics of the acceptance for the mobile AR English learning app

Dimensions	Questionnaire item	Mean	SD
Perceived Usefulness (PU)	1. The mobile AR English learning app can enrich the learning contents.	4.23	0.98
	2. The instruction of the mobile AR English learning app is so clear that I understand the learning contents effectively.	4.44	0.81
	3. The instruction provided by the mobile AR English learning app is easy to understand and follow.	4.15	0.97
	4. The mobile AR English learning app is helpful in my learning.	4.43	0.80
	5. The mobile AR English learning app can help me learn better.	3.96	1.02
	6. Generally speaking, I find out the mobile AR English learning app is useful in my learning.	4.04	0.92
Perceived Ease-of-Use (PEU)	7. It is easy to read the information on the smart phone screen of the mobile AR English learning app	4.18	0.86
	8. It is easy to use the mobile AR English learning app because it takes few efforts.	4.32	0.84
	9. I need others to help me use the mobile AR English learning app.	2.40	1.15
	10. I can immediately know how to operate the mobile AR English learning app.	4.22	0.87
	11. In this learning activity, using the mobile AR English learning app is not difficult.	4.16	0.91
	12. It is easy to operate the smart phone	4.17	0.85

interfaces of the mobile AR English learning app.		
13. In general, I find the mobile AR English learning app easy to use.	4.31	0.85

Table 3 shows the analysis of the acceptance of the mobile AR English learning app. For the perceived usefulness scale, the mean and standard deviation of the questionnaire items were 4.21 and 0.92. Most of students gave positive evaluation. The six questions with a mean exceeding four indicated the students in the experimental group highly recognized the usefulness of the mobile AR English learning app.

For the perceived ease-of-use scale, the mean and standard deviation of the questionnaire items were 3.97 and 0.90. The mean of the seven questions approached four. One of questions (Q9: I need others teach me how to use the mobile AR English learning app) is a negative item (mean=2.40, SD=1.15) indicating most students did not think they needed others to help them use the mobile AR English learning app. Although this was the first time for them to use it they could use it fluently. The results indicated the students in the experimental group evaluated the perceived ease-of-use of the mobile AR English learning app positively.

6. Conclusions

This paper employed AR interactive approach to enhancing students' English learning. Students positively accepted the mobile AR interactive English learning. The MARELA combined virtual materials with real environment. The analysis of the questionnaires demonstrated that most of students accepted the mobile AR English learning environment indicating the MARELA not only was easy to use, but also could raise students' motivation and interest in English learning. The mobile AR English learning environment could also increase their enthusiasm and motivated them to learn by themselves.

The AR learning materials could be added to worksheets and textbooks. Based on the results, the AR 3D materials on worksheets and textbook could make students more engage in learning English. The Mobile AR English learning environment, the effectiveness of AR technology on enhancing the learning environments were significant. The AR interactive learning could raise the learning motivation and motivate students.

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