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Evaluation of a gamified augmented reality mobile app to support English language learning among non-native speakers

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Abstract: This study proposes a gamified augmented reality mobile app (GARMA) to support the learning of English among college students in China. The app provides different scenes for students to learn English in a real environment. Also, it incorporates 3D images and videos supported by AR technology in each scene. Furthermore, an AR map and a leaderboard are adopted to create a gamified learning environment. The objectives of this preliminary study are to measure the performance and acceptance of the app in English language learning. In this study, the app was tested by a group of college students, English teachers and AR technicians through a survey. Based on the findings of the survey, further interviews were conducted. The results of the study show the app has good performance. Moreover, the study also reveals that the college students and teachers have a good acceptance of the app.

Keywords: Mobile augmented reality, gamification, English learning, app performance, user acceptance, vocational college

1. Introduction

In China, due to the examination-driven English teaching trend, the teaching of contents overemphasizes on book knowledge and overlooks the connection between knowledge and students' daily experience, resulting in a dull learning atmosphere (Liu, 2011). In addition to this, another study found that students are rarely given the chance for oral English communication practice (Deng, 2019). As students have few opportunities to engage themselves in orally practicing English in class, they gradually lost interest in learning English, and eventually struggle to respond to the teaching and learning process (Liao, 2012). Currently, different kinds of teaching reforms have been implemented in English classes in China such as gamification and internet-based learning methods (Yang, 2010; Min, 2015; Wang, 2007). Although the initiatives have brought some changes to the teaching form, they have not effectively solved the problem of students' lack of interest and engagement in learning English (Deng, 2019). How to cultivate students' learning interest and improve their English language ability remains a question for English teachers to ponder over in the actual English language teaching. With the further development of the technology, emerging technologies such as augmented reality (AR) technology which has evident advantages in enhancing learning interest and engagement are bringing a new round of revolution in teaching (Goldman Sachs, 2016). AR technology enables students to interact with the real environment which is considered as an impossible leaning approach before (Billinghurst, 2002). Therefore, the researchers proposed a gamified augmented reality mobile app to support the learning of English. Meanwhile, this study used a pilot study to measure the performance of the app in terms of markers, speed, interface and leaderboard and evaluate the acceptance of the app in the light of perceived usefulness, perceived ease of use and perceived enjoyment.

2. Literature review

Gamification has the potential to boost learners' motivation, engagement and performance through creating a comparative learning circumstance (Kim, Rothrock & Freivalds, 2016), combining numerous different elements such as points, badges, leader boards, rewards, feedback, story, levels and challenge to gamify the learning setting (Hamari, Koivisto & Sarsa, 2014). Integrating the gamified teaching method into English language teaching enables students to be more participative and practice English in communication (Yang 2010), as well as improve the situation of dull learning atmosphere and monotonous content (Min, 2015). Other than employing gamification as a method for teaching, AR has been used as a tool to enhance learner's motivation by combining different forms of virtual materials such as virtual figures, vivid animation and sound to construct a real and virtual learning environment (Liu, Tan & Chu, 2010; Solak & Cakir, 2015). In English language learning, AR technology can enhance students' learning interest and effectively combine with gamification to construct an attractive learning environment (Wang & Md. Khambari, 2020). Besides, some studies evaluated the applications of AR in educational areas and have proven that the applications of AR acquired good performance and acceptance including perceived usefulness, perceived ease of use and perceived enjoyment (Monroy Reyes, Vergara Villegas, Miranda Bojórquez, Cruz Sánchez & Nandayapa, 2016; Haugstvedt & Krogstie, 2012; Di Serio, Ibáñez & Kloos, 2013). This study, therefore, aims to measure the performance and acceptance of an English learning apps with AR and gamification integration in a higher education institution in China.

3. The gamified augmented reality mobile app design

3.1 The architecture of the app

The gamified augmented reality mobile app, using Ali elastic compute service and object storage service, was developed by the researchers using unity 3D software. The elastic compute service (ECS) provides a virtual server that implements a function of a leaderboard and object storage service (OSS) offers a storage function for videos. The use of the virtual server decreases the running cost without the need to buy hardware and it is flexible and convenient for a technician or a teacher to operate through remote control (Rao, Sasidhar & Kumar, 2012). The app, detecting markers located on real objects, can be used to learn English with corresponding images, videos and 3D in different real scenes. Based on the functions of the app, the whole leaning process can be flexibly designed to be a gamified AR learning process. Each learning process was designed to immerse students in a real scene to learn English and improve their writing, speaking, reading and listening skills.

3.2 A lesson conducted for the gamified augmented reality mobile app

At the beginning of English courses, students will get an AR map including many learning scenes such as supermarket, library, clinic and gym and the AR map is regarded as a course trigger marker. Then each learning group uses the app to scan the first scene they have chosen in the AR map to acquire an order of learning scenes. In this study, a supermarket scene was selected to apply the app and the five students work as a learning group. They only need to learn in the supermarket scene. After the students get paper reference materials which assist them learn English in the scene, the learning group will begin to learn English. The students will be brought into a scene of a supermarket where they will first scan the picture named AR English class to obtain a video regarding learning requirements in the supermarket scene and scan a real ten yuan to obtain a relevant English introduction regarding the supermarket and 3D snacks will be displayed. Then, the students go to shelves to scan on the snacks. Each snacks that they have scanned will be shown an AR of the elaborations on the flavor and features, which are the seed materials, namely AR videos, AR images, and real physical environment. With the seed materials, the students need to write a 100-word English essay related to the actual scenario. Then, every group must video record themselves on GARMA reading the short essay. When done, they have to click "Submit". Immediately, the app generates a timely ranking. If a group is not satisfied with the current writing and recording and wants to revise them again, the group can modify and submit them

again. The learning time will be recalculated. Materials including the iPad, the paper reference materials and essays need to be submitted to the course instructor after class for each group. When the class is over, the students can revisit their video recording by scanning a trigger image. This feature allows the students share their assignments in different scenes and different teams, which may facilitate students' discussion after class.

4. Research Methodology

This study adopts an exploratory survey method to measure the performance and acceptance of the gamified augmented reality mobile app. This performance evaluation mainly focused on the app's characteristics including marker system, speed and interface as claimed by Monroy Reyes, Vergara Villegas, Miranda Bojórquez, Cruz Sánchez and Nandayapa (2016). The questionnaire, using a Likert scale ranging from 1 (very poor) to 5 (very good) was also adopted from their work. Furthermore, because the app was also characterized by gamification element, namely leaderboard, thus, it is included in performance evaluation. Additionally, in the evaluation of the acceptance of the app, there are three dimensions in the questionnaire. They were perceived usefulness, perceived ease of use and perceived enjoyment as suggested by Haugstvedt and Krogstie (2012) who claimed that the three dimensions were significant determinants for the acceptance of AR application. In the questionnaire, the items of perceived usefulness were based the work of Hsieh, Kuo and Lin (2014) whose study focused on English discipline, which was more suitable for the evaluation of usefulness in the study. The questionnaire used a Likert scale which was a seven-point semantic differential. Besides, based on the results of the survey, the researchers implemented interviews with the participants to explore deeply the performance and acceptance of the app. Five technicians who have more than five years of experience in developing AR app participated in the initial discussion of GARMA development and knew the basic architecture of the app. Therefore, they were selected to evaluate the app. As for practitioners, five English teachers and five college students, whom have experience in using mobile app, were recruited to participate in the evaluation. These participants were introduced and briefed about GARMA before evaluation were carried out.

5. Results and discussion

The performance of the GARMA was evaluated by the five technicians through a questionnaire. The findings of the survey are presented in Table 1.

Table 1. *The Results of the Questionnaire Used to Evaluate the Performance of the App*

Items	Percentage (%)					Mean
	Very poor	Poor	Regular	Good	Very good	
1. Markers (detection)	0	0	0	100	0	**4.00**
2. Speed (app)	0	0	0	80	20	**4.20**
3. Speed (object storage service)	0	0	20	80	0	**3.80**
4. Leaderboard (virtual server)	0	0	0	60	40	**4.40**
5. Interface	0	0	0	100	0	**4.00**
Total	0	0	4	84	12	**4.08**

According to Table 1, it showed that the total average mark was over 4.00. All of the items except item 3 (Speed of object storage service) obtained over 4.00 mean value. Item 4 (Leaderboard) had the highest mean value (M=4.40). However, item 3 (Speed of object storage service) had the lowest mean score (M=3.80). The results showed that in general, the performance of the gamified augmented

reality mobile app acquired a good feedback from the technicians. The feature of the leaderboard was greatly approved by the technicians. However, the performance of the speed of object storage service just reached a standard performance. The object storage service is related to the video display and it will impact the corresponding videos to superimpose on the markers while students scanning the markers. In the further interviews, some of the technician participants suggested that (i) the AR videos' response speed need to be upgraded, (ii) a bigger cloud storage service is needed for the objects, and (iii) a more structured graphical user interface could improve the mobile app usability among college students. However, it is worth noting that addressing both recommendations will incur more costs to the researchers.

The findings regarding the acceptance of the gamified augmented reality mobile app were collected from five college teachers and five students and displayed in Table 2.

Table 2. *The Findings of the Questionnaire Used to Evaluate the Acceptance of the App*

Items (Perceived Enjoyment)	Min	Max	Mean
PE1 Disgusting-enjoyable.	6	7	6.50
PE2 Unpleased-pleasant.	6	7	6.40
PE3 Dull-exciting.	6	7	6.50
PE4 Boring-interesting.	6	7	6.60
Total mean	**6.50**		
Items (Perceived Ease of Use)	Min	Max	Mean
PEU1 Interaction with the app is clear and understandable.	6	7	6.70
PEU2 Interaction with the app does not require a lot mental effort.	6	7	6.70
PEU3 I find the app easy to use.	5	7	6.30
PEU4 I find it easy to get the app to do what I want it to do.	5	7	6.20
Total mean	**6.48**		
Items (Perceived Usefulness)	Min	Max	Mean
PU1 The app can enrich the learning contents.	6	7	6.50
PU2 The instruction of the app is so clear that I understand the learning contents effectively.	6	7	6.50
PU3 The instruction provided by the app is easy to understand and follow.	6	7	6.60
PU4 The app is helpful in my leaning.	6	7	6.70
PU5 The app can help me learn better.	6	7	6.60
PU6 Generally speaking, I find out the app is useful in my learning.	6	7	6.50
Total mean	**6.57**		
Total mean for the acceptance of the app	**6.52**		

According to Table 2, the app was well rated with an average score of 6.52, which showed that the teachers and students generally had a good acceptance of the app. Moreover, the perceived enjoyment achieved a high mean value (M= 6.50). All four items obtained high mean values and each score of the all items was 6 or 7. Item PE4 (Boring-interesting) was well rated with the highest mean value (M= 6.60). The findings showed that the students and teachers enjoyed the learning process and felt interesting in learning English. Based on the results, the researchers conducted further interviews. The students claimed that the function of the leaderboard was interesting and it provided a sense of competition, which motivated them to learn English. This finding is congruent with Yang, Quadir and Chen (2016) who revealed that leaderboard ranking had positive influence on students' English learning. Besides, the participants also stated that learning English in real environment also made them feel interesting in the whole learning process through scanning the real objects and interacting with the real learning environment. The finding is confirmed by Hsieh, Kuo and Lin (2014) who claimed that AR environment cloud enhance students' enthusiasm and interest in learning English.

Furthermore, according to Table 2, the ease of use of the app also acquired a good rating with the total mean value of 6.48. The minimum score of the four items was 5 and the mean values of the four items ranged between 6.20 and 6.70. Item PEU1 (Interaction with the app is clear and understandable) and item PEU2 (Interaction with the app does not require a lot mental effort) both obtained high mean values (M=6.7). However, item PEU3 (I find the app easy to use) and item PEU 4 (I find it easy to get

the app to do what I want it to do) were relatively low with the mean values of 6.30 and 6.20 respectively. Overall, the results indicated that the ease of use of the app was good. Hsieh' study (2016) reported that AR was easy to use echoed the finding. However, the findings also showed that there were still some issues in the process. Based on the findings, participants are interviewed and reported that the learning process was easier to control and understand than they expected. They thought that the interface was helpful for them to understand how to operate the app. Also, they considered that the marker detection was easy to control and the respond speed is good. But one student pointed out that the video loading needed to be improved to enhance the ease of use.

Additionally, according to Table 2, the usefulness of the app was well rated with a mean score of 6.57. All the six items had a mean value over 6.50 and item PU4 (The app is helpful in my leaning) achieved a highest mean score (M=6.70). The results indicated that the participants considered that the app was useful for their English language learning. Moreover, the further interviews showed that the participants thought that the app provided more opportunities and spaces for learners to practice English in whole learning process, which was useful to improve English writing, speaking, reading and listening skills. Besides, the findings of the interviews also pointed out that interacting with the real learning environment was useful to improve their English abilities, especially the speaking skill. This finding is supported by Liu (2009) who claimed that real-life situation can effectively improve speaking skill. The excerpts of evidences of interview transcripts:

Zhang (student): "Compared to traditional English class, this learning method lets me interact with items in a real supermarket and scan the real money to acquire the learning content, which motivated me to learn English, and the process is very interesting. Besides, the leaderboard is also interesting and I become more likely to communicate in English in this environment".

Zhou (student): "the interface is easy to understand and the app is easier to use than I imaged before. But if the video loading can be faster, it should be better".

Li (teacher): "In whole learning process, compared to the traditional English class, this app provides many opportunities and spaces for students to practice English including writing, speaking, reading and listening skills, which is useful for improving English abilities".

Based on the results offered by the participants, the technical experts gave positive comments regarding the performance evaluation of the gamified augmented reality mobile app. Also, they confirmed that its performance can effectively support the implementation of various teaching aims. Besides, the app was considered to be a useful and interesting app for learning English and acquired good acceptance. Although GARMA was highly rated by all the participants, many parts still need to be further refined and optimized.

6. Conclusion

GARMA is developed to provide an immersive English learning environment by incorporating AR technology and gamification elements in a real scene. This app may be helpful in immersing students in a real location to learn English, providing a more flexible and interesting learning process that is relatable to daily encounters. The findings of this study suggest that GARMA has good performance in the learning process and also obtains good acceptance in English language learning. However, the app also needs to be further improved, especially in the object storage service. Although the sample size is small, it is worth to note that the aim of this study is to improve the app, rather than generalizing the findings to a larger population. The suggestions collected from the participants are essential in improving GARMA so that it can be utilized as a new learning approach to learn English in several other different scenes. The researchers will also continue to study the effect of GARMA in English language learning and explore deeply on the learning process through the gamified AR environment.

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