Effectiveness of Enhancing Classroom by Using Augmented Reality Technology

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Abstract. The use of augmented reality (AR) has become an opportunity to enhance teaching approach. AR is an amalgamation of multimedia information with 3D graphics, images, animations and sound to support the user's perception. The aim of this study is to design and evaluate classroom learning through AR technique for teaching science subject to secondary school students. The proposed study integrated AR learning application in an interactive learning environment. A quasi-experimental design of the pre-test and post-test for non-randomized control group was employed for this project and the participants consisted of students of secondary schools in Thailand. The results indicates that students were satisfied at the highest level by the learning activities and acquired the target knowledge as well.

Keywords: Augmented Reality · Blended learning · The efficient Students' achievements

1 Introduction

Science and technology are the significant issues to develop the country and improve the quality of life. Teaching and learning of Science subject is difficult to comprehend if there are limited of equipment and student do not practice by his/herself. With rapid development of science and technology, many countries foresee on the importance of science education to enhance the quality of life and standard of living by harvesting knowledge and education. Learning from additional media, it will help students to understand and have a good attitude towards science education.

Now Thailand is facing with an education crisis and needs to reform education by focus on critical thinking skills and the results of the Program for International Student Assessment (PISA) in 2015 showed that Thai children were ranked 55 [1]. The Ministry of Education is currently adjusting the curriculum based on the modern technology. STEM education helps to promote teaching Math and Science for children to insight in the contents.

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Augmented Reality (AR) technology is a popular technology applied in education and it can integrate the real world with the virtual world through devices. AR acts as the media to make it possible to study more details and simulate the environment to make it real. AR technology is an innovation for active learning to help in learning and teaching both students and teachers [2].

Also, there are much of research shown that augment reality applications based on mobile devices play an important role in learning and teaching nowadays [3, 4]. Therefore, this research aims to apply augment reality approach based blended learning to enhance learning ability of junior high school in science subject.

2 Related Works

The section shows an overview of the literature in augmented reality based on mobile application and blended learning to scope and define the theory and approaches adopted throughout this research.

The use of mobile technology acts as a tool to deliver electronic learning materials to both students and teachers with no longer barrier by space and time and mobile is integrated AR technology to enable users to have an experience within specific context. Augmented reality is defined as "the technologies that make the virtual objects to the real world [5]. Pokémon Go is a free-to-play, location-based augmented reality game created by Niantic and Nintendo that enabled players to find the Pokemon from a place in the real world and create communities [6]. According to Delianidi et al. [7], a mobile augmented reality (mAR) blended learning application was implemented to teach for primary school pupils and revised by exploiting the personalization techniques. Kaufmann [8] applied AR to remote collaboration by sharing a common virtual learning environment and virtual learning materials. Students participate to visualize and interact with lesson directly through "markers" to produce supplementary information to student rendered in a multimedia format. To improve feedback loop between students and lecturer, augmented reality techniques was applied to provide communication and interaction during lectures and the result was positive the perspective both students and lecturer [9]. Kularbphettong implemented AR application based on mobile to enhance learning of student in Physics subject and the student achievement was effective [10].

Blended learning is an innovation that combines modules, teaching and learning together through network to make learning more effective than listening to lectures in the classroom. Furthermore, it will focus on choosing the right media and the right learning objectives in various ways to increase the potential of teaching [11]. In addition, blended learning is the integration of face-to-face with online learning and support the accessibility, affordability, and ease of eLearning with the personalization, immediate feedback, and social interaction of traditional education [12]. A convergence of Augmented Reality (AR) with blended learning environment was used to learn for teaching English as a foreigner language [13]. AR-based blended learning was applied as scaffolding to better support blended learning strategies [14]. AR and blended was applied to teach the Marching Cubes algorithm and made students to understand and view through the camera [15]. Also, there are much of research analyzed these

activities from the perspective of how AR was set in each activity to enhance learning and teaching.

3 Research Objectives

This section describes the objectives of this project and there were three primary objectives of this study:

- To develop a 3D augmented reality system on learning a science subject for junior high school.
- To evaluate the efficient of this application to meet the criteria of at least 80/80
- To compare Students' achievement between a control group and an experimental group.
- To study students' satisfaction of this AR application.

4 Research Methodologies

The purpose of this research was to develop AR mobile application and examine student perceptions regarding the use of an AR mobile system in learning a science subject for secondary science education. The research was a quasi-experimental research aimed at developing and finding the efficiency of this application to meet the criteria of effective education, with qualitative and quantitative research combined to develop this application, and enhance learning and teaching in a science subject.

Using a deductive approach. The sample of this study consisted of junior high school students in the second semester of academic year 2018. The process of designing amalgamated with blended learning consists of six steps as indicated below:

- The first step was to integrate teaching materials and review the related theories. This study focuses on studying student's behavior, learning objectives, content, tests, summaries and the environment.
- The second step was to identify learning activities in each unit from the curriculum and decide how to evaluate each learning activity.
- Assessment was prepared for the evaluation of the 3D modeling from experts.
- The pre and posttests were determined with the multiple-choice format.
- The application was implemented and samples were examined with the research materials.

Rapid application development (RAD) was used to develop the purposed application and RAD is the software development approach based on prototyping and iterative development [16, 17]. According to Martins [18, 19], RAD is divided in four distinct steps: requirements planning, user design, construction, and cutover steps as shown in Fig. 1. The first step of requirements planning is a preparation step to set goals and objectives, and the goal and purpose of the lesson is to set the target. User design is the step focusing on user interaction, where models and prototypes are built for supporting users. In the construction phase, application was implemented and the

system was tested to see if it operated at an acceptable level. The cutover is the final phase including data con-version, testing, changeover to the new system, and user training.

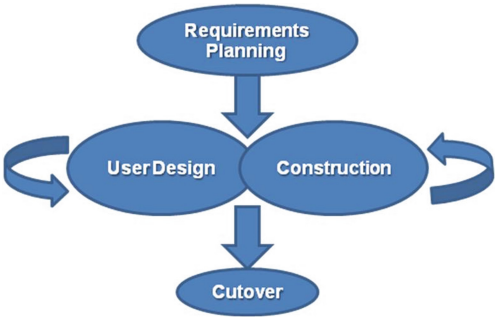

Fig. 1. Rapid application development (RAD) [18]

Figure 2 shows the system framework according to K.Kularbphettong and et al. There are four significant components including user profiling, searching, learning and testing modules. The user profile supports learners to register and edit his/her profile like personnel information, email address, username and password, and etc. students can search and learn content and knowledge about the science subjects in secondary school at level two. The contents of the learning part include 5 lessons and the presentation is a 3D augmented reality with voice and subtitles. After students had finished learning each lesson, they can take post exams and know results from the testing module of this application and the application provide post- tests and score results. This proposed application was assessed by 3 experts to verify the student's learning plan, content and the performance of this system. A 15-min pre-study presentation was conducted to introduce the students to the project. Students were asked to register personnel profiles on the application.

After the training session finished, the in-depth interviews were applied in the classroom and the samples were required to give the explanation and describe the learning situation. Data collection was conducted through a demographic survey, learning observations, and interviews. The data were analyzed by the statistical means, and standard deviation (S.D.). The level of the significance was p = 0.05 that formed the basis for or rejecting or not rejecting each of the hypotheses. To evaluate the effectiveness of learning material collected data from test and post-test was analyzed and measured by using E1/E2 effectiveness with 80/80 condition.

$$E_1 = \frac{\frac{\sum x}{N}}{A} \times 100 \tag{1}$$

$$E_2 = \frac{\frac{\sum F}{N}}{B} \times 100 \tag{2}$$

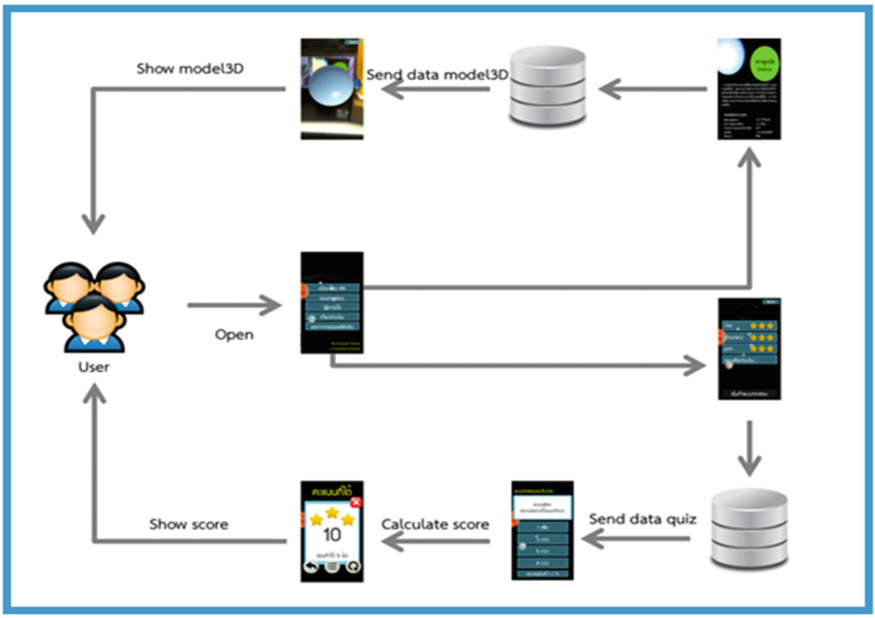

Fig. 2. The overview system of this system

When
E1 = the efficiency of the developed material
E2 = the efficiency of performance result
$\sum X$ = total score from lesson testing
$\sum F$ = total score from post-test
A = Total score of lesson testing
B = Total score of post-test
N = total number of students

Moreover, this research used questionnaires to test and evaluate the satisfaction of the student's learning in the programming language with games and a 5-point Likert scale was utilized to range from "strongly satisfaction" to "strongly dissatisfaction".

5 Empirical Study and Results

The purpose of this study was to examine students' learning achievements accomplished through the use of an augmented reality mobile in a science course. The results of this study are presented in three sections: evaluating the performance of the proposed application by experts; assessing students' learning achievements; and evaluating the satisfaction of the student's learning.

5.1 Evaluating the Performance of the Proposed Application by Experts

Black box testing and questionnaires were applied to test and evaluate the qualities of the system by three experts. Black Box testing was evaluated the error of the project as following: functional requirement test, Function test, Usability test, Performance test and Security test. The ability of this application was assessed by Functional Requirement test in needs of the users and Functional test was used to evaluate the accuracy of the system. Usability test was tested the suitability of the system. Performance test was used the processing speed of the system. Finally, Security test was evaluated the security of the system and Table 1.

Table 1. The results of he results of Black box testing

	Experts	
	$\bar{x}$	SD
1.Function requirement test	4.67	0.47
2. Functional test	4.69	0.47
3. Usability test	4.44	0.62
4. Performance test	4.49	0.50
5. Security test	4.40	0.65
Summary	4.53	0.54

The results were satisfactory, mean value for experts was 4.52, and standard deviation was 0.54 respectively.

5.2 Assessing Students' Learning Achievements

The comparative analysis of the learning outcome was conducted with 40 students learning with AR application and before starting test, students were took pretest to evaluate the knowledge of students. To analyze the progress of the student learning, the results showed that the students had 22.45 and 35.15 percent learning achievement before and after test, from the 40-point scale. The t-test value is 19.32 (Tables 2, 4 and 5).

Table 2. The results of assessing students' learning achievements

	Group	Score		E1/E2
		$\bar{x}$	S.D.	
Pre-test	40	22.45	1.50	81.62
Post-test	40	35.15	2.67	85.33

In addition, the performance of the proposed application, the efficiency of E1/E2 is 81.62/85.33, indicating that the game lessons effective 80/80 criteria.

Table 3. The results of assessing students' learning achievements

	$\overline{x}$	S.D.	Level
Teaching technique	4.63	0.48	Very high
The characteristic of the AR application	4.60	0.50	Very high
Teaching material	4.62	0.53	Very high
Quiz and evaluation	4.67	0.45	Very high
Total	4.63	0.49	Very High

Table 4. The results of the satisfaction of the student's learning in teaching technique

	$\overline{x}$	S.D.	Level
Teacher uses a variety of teaching methods appropriate to the subject matter	4.55	0.44	Very high
Teacher uses techniques to teach students to understand them more easily	4.72	0.48	Very high
Students have the opportunity to ask questions, express opinions, discuss, give advice and listen to their ideas	4.63	0.51	Very high
Teachers use language to teach that students can understand. It's easy and appropriate for content	4.65	0.47	Very high

Table 5. The results of the satisfaction of the student's learning in the characteristic of the AR application

	$\overline{x}$	S.D.	Level
Screen layout and design	4.42	0.49	High
Fonts, sizes and colors	4.72	0.50	Very high
Main menu easy to understand	4.65	0.51	Very high
Linking within the lesson	4.67	0.48	Very high

5.3 Evaluating the Satisfaction of the Student's Learning

The satisfaction of the student's learning was assessed by a questionnaire and the sample consisted of 40 students (number of boys = 26 and number of girls = 14). Data is presented in terms of descriptive statistics.

Table 3 shown the level of student satisfaction toward teaching and learning management and the overall is high (Mean = 4.63). When considering each aspect, it was found that the highest mean was the personality of the instructor and followed by quiz and evaluation, teaching technique, teaching material, and the characteristic of the AR application respectively. In teaching technique aspect, the level of student satisfaction toward teaching and learning management in the course increased when teachers used techniques to teach students to understand them more easily, including questions, debates, presentations, and etc.

Table 6 above describe the results for students learning satisfaction based on the teaching technique, the characteristic of the AR application, and the results of the satisfaction of the teaching material.

Table 6. The results of the satisfaction of the teaching material

	$\bar{x}$	S.D.	Level
Content is easy to understand	4.45	0.53	High
Content is clear	4.67	0.55	Very high
Content is consistent with objectives	4.59	0.53	Very high
Content is interesting	4.76	0.49	Very high

6 Conclusion and Future Works

This study examined student-learning achievements regarding the use of an AR mobile application. The experimental group showed a significantly better performance in learning achievements. Moreover, the study suggests that AR mobile system can extend learning outside the classroom and promote personalized learning. Students can enhance and improve their ability and this system supports teachers in handle and manages their course. In addition, AR is a valuable learning application: learners feel comfortable to use and learn when they had free time. In future experiments, we will be looking at how advanced technologies can support in learning preferences and interest of learners based on social networks, towards an adaptive learning for learners.

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