Preliminary Study of Mobile Augmented Reality Assisted Learning Tool

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Abstract: In this paper, we develop an Augmented Reality Assisted Learning App (ARALA) using augmented reality technology. The App would assist students learning instructions by themselves via smart phone. We also survey students' attitudes in ARALA acceptance between suburb area and urban area students. The results found the ARALA acceptance between suburb area and urban area students did not significantly differ in the experiment. Moreover, students gave some feedbacks indicated the ARALA was novel and interesting for students learning.

Keywords: Augmented reality learning, mobile augmented reality, markerless AR, technology acceptance

Introduction

The past decade, many researchers have developed various assisted teaching and learning system in education. Multimedia teaching and learning environments have offered new ways for teachers and learners to interact with various educational resources [1]. Shelton thought related discussions about how, what, and why will not fall far behind the technological development of the Augmented Reality systems [2]. The Augmented Reality technology should be lead into teaching and learning environments. Many educators and researchers are enthusiastic about the use of emerging technologies [3],

Mathematics and English are important subjects in Taiwan. The homework burden is very heavy for students, especially the subject of mathematics. There are many problems of an exercise in Mathematics textbooks or Mathematics reference books. However, problems of an exercise' answers are attached behind the books. Sometimes, teachers asked students correct answer by themselves after they finished homework. For less studious student may be directly copied the answer, but studious student is not. For example, a studious student does not have idea and a solution while he/she is writing his/her Math homework. This studious student he/she would want to find out how to solute those problems, but nobody could help him/her. He/she is dying for find out the instructions on problems of an exercise. In general, we could turn to the back of the textbooks to find answers. In this way, turning pages frequently is very inconvenient.

The remedial after-school lessons are very prevalent in Taiwan. Most of parents hope their children take remedial after-school lessons. Students live in urban area have more opportunity to take remedial after-school lessons. Those students could get more learning resources from crammer, but living in suburb area could not. For these reasons, we want to improve above-mentioned inconvenient question. We will develop an assisted learning tool to help students' learning by themselves. Furthermore, we also conduct a survey to understand students' attitudes in ARALA acceptance between suburb area and urban area.

1. Related Work

1.1 Augmented Reality

Augmented Reality (AR) is a technology variation of Virtual Reality (VR) [4]. It allows virtual imagery to be seamlessly overlaid onto views of the real world [5]. Compared with virtual reality technology, the augmented reality creation process is less expensive [6][7]. VR can simulate objects in the real world and create the environment where users can interact with the simulated objects. 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 [8]. In sum, it adds virtual objects to real world environment. In 1997, Azuma identified three common characteristics of AR scenes [4]:

- Combination of the real and virtual.
- Interactive in real-time.
- The scenes registered in 3D.

More than 450 million smart phones with camera will be sold in 2012, hence mobile AR is a significant growing market [5]. Currently it is possible to use marker-based, markerless-based, and location-based service methods to deliver a mobile AR experience. Specht, Ternier, and Greller indicted augmented reality applications to smart phones that enabled new and mobile AR experiences for users. Because of the increasing pervasiveness of smart phones, AR is set to become a ubiquitous commodity for mobile learning [9].

At present, augmented reality marker recognition focusing on technique can be mainly divided into two kinds, marker-based and markerless-based AR to register digital content for real world orientation and placement [9][10]. As for traditional AR, a marker (Fig 6) is needed to serve as an interface for image recognition. After the image on the marker is examined by the computer, the computer produces virtual object which will appear on the marker, shown as Fig 7 [11]. In this way, location and image of the marker can be easily discovered.

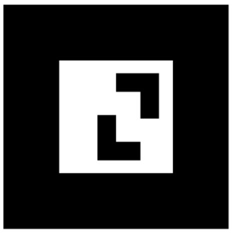


Fig 6: Marker-based AR pattern

Fig 7: Marker AR shows screen on monitor

In contrast, markerless AR using natural features such as planes, edges, or corner points has been demonstrated for camera pose estimation [12][13]. Fig 8 is markerless pattern used natural feature ‘chips picture’ and Fig 9shows Markerless AR shows the 3D model on the smart phone screen with built-in camera [14]. As for markerless AR and marker AR, the difference lies in the examination of a certain object or image. The markerless AR is more user-friendly and also gets more and more attention because of developing rapidly.

Fig 8: Markerless-based AR pattern

Fig 9: Markerless AR shows 3D model on the smart phone screen with built-in camera

1.2 Augmented Reality in Education

Several studies have applied AR to education. Construct3D is a three dimensional geometric construction tool specifically designed for mathematics and geometry education. It is based on the mobile collaborative augmented reality system. It describes developing a system for the improvement of spatial abilities and maximization of transfer of learning [15]. Liu, Tan, and Chu constructed a 2D barcode and handheld augmented reality supported learning system called Handheld English Language Learning Organization (HELLO), to improve students' English level [16]. The HELLO system integrates the 2D barcodes, the augmented reality, mobile computing, internet, and database technologies. Feng et al. presented a novel markerless augmented reality. It was based piano teaching system, which tracks the real keyboard of piano naturally [17]. Following the virtual hands augmented on the keyboard, beginners of piano can practice playing piano.

The augmented reality was not referenced until the 2010 Horizon Report [18], 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. The augmented reality technologies most likely to have an impact on education according to the Horizon Reports from 2004 to 2010. What is noteworthy the teaching applications of augmented reality are still minimal [19].

2. Research Method

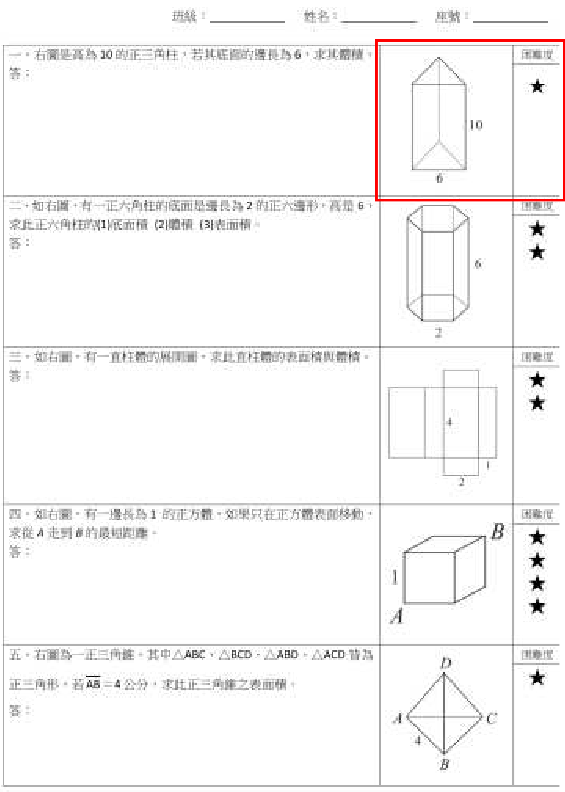
2.1 Tool Development

In tool development, we used markerless-based augmented reality technology to develop an assisted learning tool. It would assist students learning instructions by themselves via smart phone. The assisted learning tool is Augmented Reality Assisted Learning App, abbreviated as ARALA. The ARALA development environment was based on Android SDK for Eclipse and supported by Qucalcomm SDK. The Qucalcomm SDK based AR application uses the display of mobile devices as a magic lens that display an augmented world where the real and virtual worlds appear to co-exist. The application uses live camera preview images on the display to represent a view of the physical 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 [14]. Below is a list of the ARALA development processing procedure:

1. Design Markerless pattern - Design mathematic geometrical figures as the AR Markerless pattern in order to allow recognition for ARALA.
2. Create recognition feature points - Create recognition feature points use for system recognition and tracking. Fig 10 is one of geometrical figure (markerless pattern) that

is snapped from the examination questions (Fig 11). Fig 12 shows geometrical figure of feature points.

3. 3DS Max modeling - Design and model the mathematics instructions in 3DS Max.
4. Export object file - Export object file after modeling from 3DS Max.
5. Programming - Programming Open Graphic Library Embedded System for model rendering.
6. Publishing Application - Publish application and generate Android Package (apk).



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一、右圖是高為 10 的正三角柱，若其底面的邊長為 6，求其體積。 答：		困難度 ★
二、如右圖，有一正六角柱的底面是邊長為 2 的正六邊形，高是 6，求此正六角柱的(1)底面積 (2)體積 (3)表面積。 答：		困難度 ★★
三、如右圖，有一直柱體的展開圖，求此直柱體的表面積與體積。 答：		困難度 ★★
四、如右圖，有一邊長為 1 的正方體，如果只在正方體表面移動，求從 A 走到 B 的最短距離。 答：		困難度 ★★★★
五、右圖為一正三角錐，其中△ABC、△BCD、△ABD、△ACD 皆為正三角形，若 $\overline{AB}$ = 4 公分，求此正三角錐之表面積。 答：		困難度 ★

Fig 11: Examination questions of an exercise

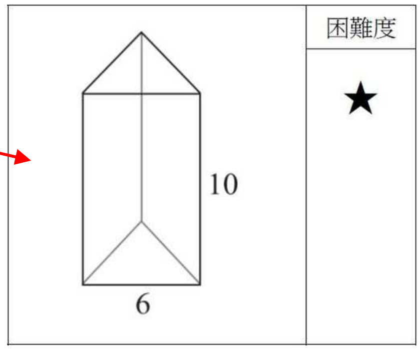

Fig 10: Geometrical figure (Markerless pattern)

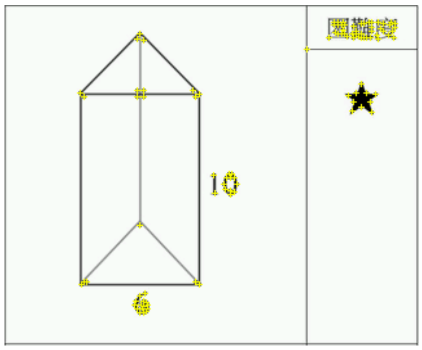

Fig 12: Geometrical figure of feature points

The ARALA operation flowchart is shown as Figure 13. First use the system, the student must holds smart phone and executes QR code scanner in smart phone. Under the premise that the smart phone has installed QR code scanner. After that, the built-in camera aims at the QR code and decrypts the internal code. Then, the smart phone will download ARALA and installation. However, the student will execute the ARALA. After that, the built-in camera in smart phone will trigger a video stream. The student aims the built-in camera at the geometrical figure and capture. The instructional learning content will be superimposed on geometrical figure and it displays by smart phone screen. Figure 14and Figure 15 show ARALA execution screen and AR display screen respectively.

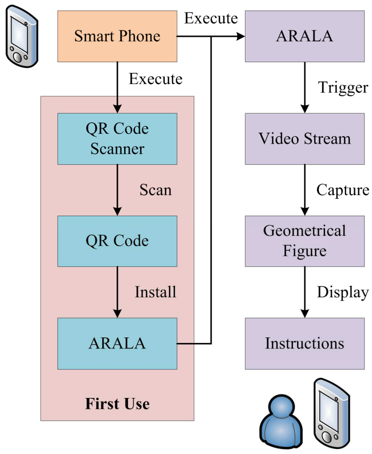

Figure 13: ARALA operation flowchart

Figure 14: ARALA execution screen

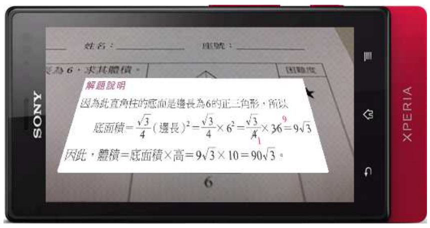

Figure 15: ARALA AR display screen

2.2 Experiment

In this preliminary study, we conducted a survey to understand students' attitudes in ARALA acceptance between suburb area and urban area students. The perceived usefulness and perceived ease of use questionnaire was used to collect the students' attitudes about using ARALA. The originated from a questionnaire was developed by Davis [20]. Figure 16 is the experimental procedure of ARALA. The questionnaire used in this study consisted of 13 five-point Likert-scale items where 1 represented "strongly disagree" and 5 represented "strongly agree". The questionnaire was reviewed by two experts to ensure content validity. The Cronbach's alpha value for usefulness and ease of use of the questionnaire was 0.98 and 0.94 respectively.

The participants were 308 seventh-grade students that operating ARALA in different schools. Their average age was fourteen years old. The participants were five classes (suburb area) in a Group A (n = 151) and five classes (urban area) in a Group B (n = 157). After receiving the explained of teacher, the ARALA experiment will begin in first class. After using the ARALA, participants were asked to complete the questionnaire and opinion feedback in second class. The total periods of experiment execution are five weeks.

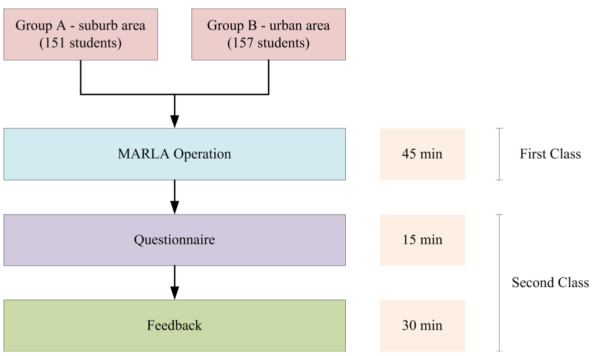

Figure 16: The experimental procedure

3. Experiment Results

After experiment, an independent sample *t*-test was used to analyze the questionnaire. The Table 1 is assessing result of the perceived usefulness and perceived ease of use in acceptance of ARALA between suburb area and urban area students. The mean and standard deviation of the questionnaire were 54.91 and 9.475 for the Group A (suburb area students) and 55.18 and 7.911 for Group B (urban area students). The results inferred that these two groups did not significantly differ in the experiment ($t = -2.66$, $p = .790 > .05$).

Table 1: The independent sample *t*-test on the usefulness and ease of use of the Group A and Group B.

Group	N	Mean	Std. dev.	t	Sig. (two-tailed test)
Group A	151	54.91	9.475	-.266	.790
Group B	157	55.18	7.911		

$^{*}p < .05$

After questionnaire, participants were asked to wrote opinion feedback sheet about "Do you have any suggestions and ideas for using the ARALA?" This study collected opinion feedback of students. The examples of students' opinion feedback were listed as follows.
"I have used QR code that is easy to use."
"The App (ARALA) is very interesting."
"The smart phone must be installed QR code scanner before I can use. Therefore, it has a bit of trouble."
"Using ARALA is very funny."
"I had a little trouble installing QR code scanner."
"It is difficult to find where is ARALA after I use QR code to install app."
"The App could help me to learn."
"This technology is very amusing"
"I never see that, it's very incredible."

This study has test fifteen smart phones, the brand of smart phone includes HTC, Sony, Sony Ericsson, Samsung, and Acer. We found only one smart phone can't installation. The reason is the ROM of smart phone less than 512, and RAM is too low. The perceived usefulness and perceived ease of use in acceptance of ARALA between suburb area and urban area students did not significantly differ. Both of the acceptance of ARALA from them is very high according to statistic result. Perhaps the augmented reality is a state-of-the-art technology. From the feedbacks of students, the suburb area and urban area students are interested in ARALA.

Conclusions and Future Work

In this preliminary study, we develop an Augmented Reality Assisted Learning App (ARALA) by markerless-based augmented reality technology. The ARALA would assist students' learning instructions by their own via smart phone. The aimed of this preliminary study, we conducted a survey to understand students' attitudes in ARALA acceptance between suburb area and urban area students. The results inferred the ARALA acceptance between suburb area and urban area students did not significantly differ in the experiment. According to some feedbacks from students, we found ARALA was novel and interesting for students' learning. In the future, we will have further research to carry out experiment, learning effectiveness, of ARALA on students.

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