Development Framework Based on Mobile Augmented Reality for Pre-Literacy Kit

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Abstract—Mobile technology, augmented reality, and game-based learning are some of the key learning technologies that can be fully optimized to promote pre-literacy skills. The problem is how to design an effective pre-literacy kit that utilizes some of the learning technologies. This paper presents a framework based on mobile augmented reality for the development of pre-literacy kit. This pre-literacy kit incorporates three main components which are contents, design, and tools. A prototype of a mobile app based on the three main components was developed for promoting pre-literacy. The results show that the children and teachers gave positive feedbacks after using the mobile app for the pre-literacy.

Keywords—Framework, mobile technology, augmented reality, pre-literacy skills.

I. INTRODUCTION

IN a traditional class setting, printed books and cards are the main materials for cultivating pre-literacy skills. Now, in the 21st century, the availability of ICT tools has contributed to a vast number of digital materials for pre-literacy. Starfall is an example of a successful use of web technology for learning from alphabets, phonics to reading. How to take advantage of these two methods which are printed and digital materials? A technique that can enhance children perception towards a learning object by combining printed material and digital material in a same view is called augmented reality (AR). Therefore, users of AR interfaces can have real-world experience deeper because they are enriched with the virtual world compared with the use of computer interfaces that involve only virtual world [1]. There are a number of elements or equipment essential in running an AR based application. These elements are: smart phones, installation software for AR on smart phones, cameras, and markers for detection. When the smartphone's camera scans and detects the marker that has been specified for the application, virtual objects that were designed for the marker will be displayed on the smartphone screen.

The use of mobile technology is also an emerging technology in education. According to [2], three technologies that will impact directly on the English Language Teaching (ELT) for the future are mobile technology, AR, and game-based learning. Examples of using AR for ELT are Augmented Reality English Learning System [3], Augmented Reality English Vocabulary Learning System [4], and Handheld English Language Learning Organization [5]. Applications that incorporate all or two of these technologies are expected to provide many benefits to students. The problem is how to develop a mobile AR app that is effective for promoting pre-literacy skills. The objectives of this research are to design a framework for mobile AR for pre-literacy, to develop a mobile AR application for pre-literacy and to evaluate the application.

II. DEVELOPMENT FRAMEWORK FOR MOBILE AR FOR PRE-LITERACY

In order to provide a guideline for the development of mobile AR app for pre-literacy, a framework has been developed as shown in Fig. 1. The details of the framework will be explained in the following sections.

A. Input

The inputs for this framework are subject, level and context. Subject is the target learning area; level is the age of the children and context is the environment whether it is indoor or outdoor. In this study, the focus is on the first phase in promoting pre-literacy skill which is letter recognition. Therefore, the selected subject is pre-literacy skill for letter recognition, the target level for this application is for 4-6 years children and the application is intended to be used for indoor environment.

B. Process

The process of developing the application consists of three main components which are content, design, and tools.

The content is the learning materials which consist of printed and digital material. The printed materials for the proposed application will be printed letters with pictures and the digital materials will be sound for each letter, songs related to each letter and 3D model for each of the letter.

The design component determines how the contents will be organized in the mobile application. The application was designed to have three modules which are spelling, song, and exercise. The application was also designed to highlight sensory based activities, repetition and standardization. For promoting sensory based activities, printed cards will be used as markers. For repetition and standardization, every printed letter will be assigned with a digital sound and 3D models. Songs related to letter can be included to engage children. The sound for each letter can be repeated so this will promote self-paced study.

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The tool component is about developing the mobile application based on the design. The application will be installed on a smartphone and the markers will be printed so that the AR application can track the marker in order to overlay related digital materials.

C. Output

Five elements will be expected from the usage of the application which are focus, active, curiosity, positive action and interesting.

III. RESULTS AND DISCUSSION

A testing was conducted with two parents, two teachers and 22 children in order to evaluate the mobile application.

A. Questionnaire

During the test, a questionnaire was used to identify the feedback from parents and teachers on the application. In this questionnaire (Table I), there are four categories based on

elements in the framework which are A for contents, B for design, C for tools and D for output.

B. Modules

Fig. 2 shows the overall elements related to the pre-literacy kit. There are three modules which are spelling, song, and exercise. For the first module, spelling module, the smartphone's camera will track a marker which is a printed letter. Once the marker has been recognized, a 3D model will be displayed above the marker to augment the printed letter as shown in Fig. 3. The appearance of the 3D model is accompanied with the audio which is the sound of the printed letter. Therefore, the learning becomes contextual since children can connect the card with its sound. The appearance of a 3D model will attract children to become more engaged with the learning process. For the second module which is a song module, a song video related to the printed marker will be played on the mobile phone screen (Fig. 4).
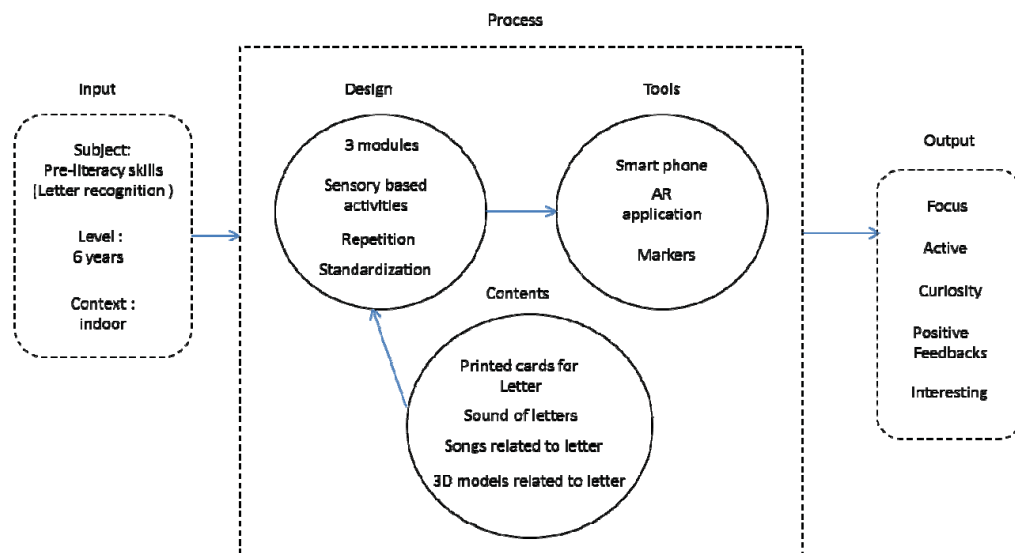

Fig. 1 Development framework based on mobile AR for pre-literacy

TABLE I
QUESTIONNAIRE

Item	Questions
A1	Complete learning materials
A2	The application system is suitable for teaching and learning
A3	The application supports the learning process
B1	The application is simple to use
B2	Insufficient training materials
B3	The time given is sufficient
B4	Provide opportunities and exercises for children
C1	Tools for using the application are available
C2	Learning tools such as markers are inadequate
C3	The application is running smoothly
D1	Children become more focus
D2	Children become active when using the application
D3	The curiosity of the children increases
D4	Children give positive feedbacks on using the application
D5	This application is boring

Finally, children can move to the last module which is exercise module. The application becomes more interesting with the use of virtual button in the exercise module. In this module, children have to use their hand to make a selection of the correct answer. Fig. 5 shows the marker of the exercise. When the camera of the phone detects the marker, two virtual buttons will be overlaid on the marker as shown in Fig. 6. The children must move their hand to the selected virtual button in order to choose the initial letter for the given image. If the answer is correct, the phone will output a 3D model with a sound as shown in Fig. 7. In this exercise, children have to move their hands on the marker and this will also promote a sensory based activity.
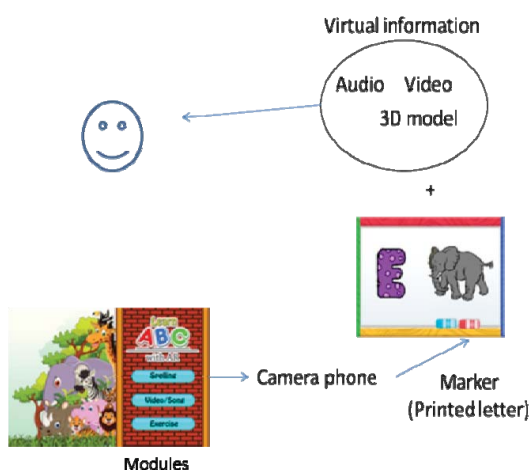
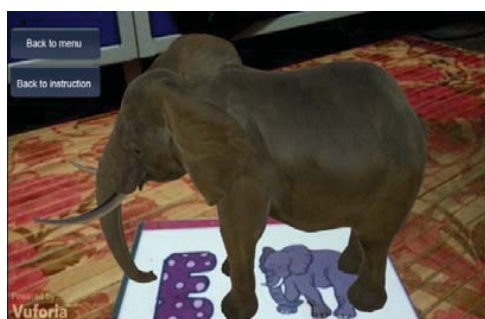Fig. 2 Overall elements related to the pre-literacy kit

Fig. 3 A model of elephant with sound of letter E augmented the printed E card

Fig. 4 Song related to learning sound of letters
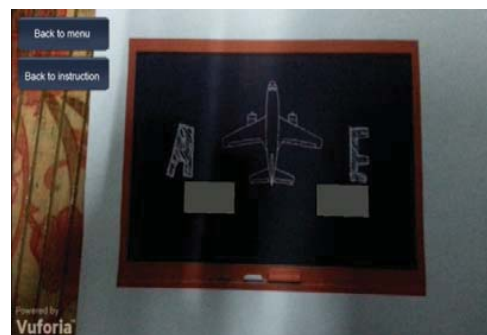

Fig. 5 Marker for exercise module

Fig. 6 Virtual buttons are on top of the marker

Fig. 7 3D model of an alligator with sound

C. Tools

Equipment that is required for this study is a smart phone that has a camera with minimum size of 5 megapixels. This is because AR technology requires a camera that has an appropriate focus in order to process the tracked marker. The AR application was developed using Unity 3D and Blender. The application needs to be installed to a smartphone with Android operating system. Teaching materials which are printed letter are provided in multiple copies.

D. Procedure

Teachers and children were given explanation and training on how to use the mobile AR application. A demo was done where students and teachers saw the results displayed on a mobile phone screen when the camera is able to capture the target marker that has been provided. Fig. 8 shows some children look at a 3D model on the mobile phone screen. The children will able to see a 3 D model related to the letter on the marker and listen to the sound of the letter. The children can use the spelling and song module in repetition and then switch to the exercise module. The reactions of children when using AR applications such as in Figs. 8, were observed and recorded. The teachers were interviewed and answered questionnaires based on the items in Table I.

Fig. 8 Children are active and focus when using the application

E. Analysis of results

The teacher feedbacks on four categories which are A for contents, B for the design, C for the tools and D for the output, were positive. Based on the scale used, 0 (disagree) and 1 (agree), the teachers agreed to the 14 items in the questionnaire in Table I. Only items D5 (the application is boring), got the scale of 0. Through observation, the children found to be active and interested in directing the target of teaching materials to be detected by a smartphone camera. One teacher stated that: "Students will be more interested to learn"

Feedbacks from parents who used the application at home were also positive. A mother also gave a suggestion for improvement of the application which is: "Use an existing book as markers. It will more interesting and attractive if it has many exercise modules for kids"

Through observation, the children focus on 3D models that appear on the screen of the mobile phone and listen to the audio related to the 3D model. This application not only can help students to engage in the learning process, but it also can help teachers with diverse English proficiency. Furthermore, children can repeatedly listen to the audio on teaching materials either inside or outside the classroom. In fact, parents can also install the application on their phones and so their children can revise again on what they have learned at school. Through interviews conducted at a pre-school, teachers like to use an application that can support teaching by using the existing teaching materials. Thus, future studies will look at the existing teaching materials to be used as markers for AR applications. Future research will also look at the cognitive effects of the use of AR in pre-literacy.

IV. Conclusions

The feedback of teachers and children on the use of mobile technology AR is positive in the pilot study conducted in a pre-school. Children were having fun in using the application and the teachers also liked the addition of a variety of teaching aids. This is due to the augmentation of reality that can add digital information on learning objects and the mobility of the app. However, the impact of AR applications to increase the pre-literacy skills has not been studied in a longer period. Therefore, research should be done to look at the real problems faced by teachers in pre-school, and plan an appropriate action so that the use of mobile AR can be integrated with the everyday experiences of children through the interaction with objects and daily locations.

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