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Fun Learning with AR Alphabet Book for Preschool Children

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Abstract

This paper describes the design and evaluation of an AR alphabet book, an Augmented Reality based book for teaching the alphabet to preschool children. Used together with camera and computer, children could view the superimposed virtual alphabet in a fun and interactive manner using the pattern markers as an interaction tool. Generally, teaching young children could be difficult this is due to the focus of young children is different from elderly since they could only focus on something for short period of time. Introducing the fun and interactive learning could grab the attention therefore enhance teaching and learning for young learner. Fun-learning emphasized interactive learning through play, songs; dance, drama and the use of information and communication technology (ICT). Researches showed that fun learning also increase the ability to memorize and understanding of the user. Flashcard is one of the learning approaches to teach children the alphabet. The tangible manner of flashcard introduce the interaction of learning therefore it could create the joyful learning. However, the potential of flash-card could be further enhance through the use of AR technology. Therefore, introducing the use of AR could encompass fun learning since AR offer rich media learning. Besides displaying each alphabet upon presentation of its corresponding pattern marker, children have the options to see 3D models of objects that begin with each alphabet character. Additional book features includes pattern markers for children to view animation of how each letter is drawn and jigsaw puzzle game for each letter to test children understanding. An informal study was conducted among 15 preschool children aged between 5-6 years old to examine user perception of the book. The preliminary results indicate the children reacted positively towards the books; most reported they like and enjoy using the AR book. Observation of the children behaviors during study corroborates this finding. Most students requested to use the AR book repeatedly. These results suggest the potential of AR book as a tool to create fun learning environment especially for preschool children. Furthermore, the brief interview with the teacher of the preschool also suggested that the system seem to grab the attention of the children.

Keywords: Augmented Reality; Education; Alphbet Learning; Fun Learning.

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1. Introduction

Alphabet knowledge is a vital skill for children to acquire for learning to read and write [1, 2]. According to several researchers, alphabet knowledge is considered to be one of the best predictors for children to acquire their reading skills [1, 3, 4, 5, 6]. As such, many researchers and educators assert that alphabet knowledge should be developed as early as prekindergarten or latest in kindergarten before entry to school where formal learning occurs [4]. Several researchers claim that deficiency in such knowledge could portend later reading difficulties among children [5, 6, 7]. Alphabet knowledge denotes among others knowing the letter names and understanding that they form a class of labels of letters. Having such knowledge further indicates children need to match the letter shape with its name and also its corresponding one or two sounds for which it stand in written word [4, 7].

Traditional learning of the alphabet is often through flashcards and singing. Whilst singing can be an engaging activity based learning approach, one major drawback to it is student tend to memorize the order of the alphabet. Most of the time when ask to name a single alphabet, student tend to repeat from the beginning until they came to the alphabet in question. Flashcards which tend to be static 2D images of the objects that represent the alphabet is still a popular teaching approach due to its usage simplicity. Moreover, numerous commercially available flashcards are at the teachers' disposal. However, with the advent of Information and Communication Technology (ICT), the past decades has seen the adoption of ICT in technology based learning whereby digital format of teaching and learning materials have been widely used e. g. [8, 9]. Learning of the alphabets is no exception. Numerous educational and edutainment software have been created for learning the alphabet.

Recently with the emergent of AR, the technology has been getting researchers and educators' attention as an interesting alternative and exciting ways of creating teaching and learning tools. Despite this, very few have explored its use in the learning of alphabet. An AR or Augmented reality refers to the augmentation of virtual objects onto the video stream view of the real physical world, is a technology that provides a unique interactive interface in which user can work and interact simultaneously with the real world and virtual objects in a natural way [10, 11]. Unlike the traditional method of interaction using mouse and keyboard, the AR interface metaphor is based on user using the physical objects such as cards to interact with virtual objects in natural way [10, 12]. Being different from the traditional interface method, this will naturally grab the student attention [13]. To educate students, a particularly young child is a challenging endeavor; getting their attention, engagement and motivation in learning process are some of them. Thus, with its unique features AR technology could be used as an alternative interesting educational delivery method as it will not only led to high motivation in student but also its intuitive and user-friendly interaction method could be used as an attention grabber engaging learning tool.

This paper describes the development and evaluation of an augmented reality based book for learning the alphabet. Section 2 provides the research background and related work. The AR alphabet book is described next, followed by the results of the evaluation study. The final section concludes with discussion of results and plans for future works.

2. Background of Study

Teaching young children could be difficult task. Therefore, educators need to carefully associate the factor which will introduce the engaged learning environment. Two aspects of related works are explored in this study which are learning factors, particularly, fun learning and the use of AR to support learning.

2.1. Fun Learning

In education, teaching and learning method is one of the most important factors. In many cases, teaching methods could create difficulty or barrier in learning and understanding of students [14] especially, for young children. Fun and interactive learning is one of the powerful pedagogical factors which could yield to create the interactive and engaged learning environment [8]. Anne Haas Dyson, a professor of curriculum and instruction from College of Education has mention that "Play is where the literacy and learning begins" because when the students play, they will participate, think, discover the ideas and gain the experiences [15]. Dyson also point out that "the kids do not respond well to sitting still in the desk and listening. They need stimulation [15]. Element of fun is an important aspect of educational software. Malone, who initiated research on the study of fun in software proposed several design guidelines on how to incorporate the fun factor in software [16]. Until recently, research in fun factor in software has been very sparse.

Describing fun is not trivial. Caroll [17] describes things as fun as "when they attract, capture, and hold our attention by provoking new or unusual emotions in contexts that typically arouse none, or arousing emotions not typically aroused in a given context." Malone & Lepper associated fun with motivation [18]. They investigated motivations, particularly designing intrinsic motivating learning environments in making learning fun. They proposed a set of guidelines in for the design of intrinsically motivating instructional environment which includes a set of factors for individual motivations and interpersonal motivations.

2.2. Augmented Reality (AR) in Education

Recently, there has been a proliferation of researches into the use of AR technology in various fields of application including education. In education, the early work of exploring potential of AR to support learning is based on the work of Billinghurst when he first created the AR popup book called "MagicBook" [10]. This later inspired many researchers in various domains. In science learning, Karawalla et al. [19] developed an AR application to explore the potential of AR to support spatial learning in the study of relationship between earth, sun, moon and the time. They perform a comparative study between AR based approaches and the role play activities and results showed that AR positively assists students in understanding the concept. Chen, [13] investigated how the students interact with AR system and evaluate the perception of students on learning about Amino Acid using AR system called "Protein Magic Book (PMB)". The results showed that students liked learning using AR since it was portable, provided a clear image of Amino Acid as well as they could observe the model in detail. However, some students found that the AR marker is not easy to use since it developed based on marker recognition, when the student flip the marker, the model disappear. PhysicsPlayground was developed to facilitate the students in mechanics learning. The system allowed students to actively build their own experiments and study them in 3D. It provides simulation of the experiment [20].

Live Solar System, was developed and aimed to help the students of form 3 in learning chapter on Star and Galaxies. The system allows students to explore the solar system. The research focus is on the usability of the system which concentrates on the ease of use, learnability and effectiveness by using pre-test and post-test. The result shown that the system is easy to use and also help the students in understanding about the subject study. [21]

For young children, few works had been done to investigate the potential of AR in supporting learning. Ucelli et al., [22] developed the system to teach the children the theory of color. The study showed that AR system offered engaged and active learning environment. Children exhibited the constructivist practice. ARGarden was developed based on the pedagogical agent based system which acts as a learning companion to enhance the learning experience. ARGarden help children to explore the growing and factors that impact the growing of flower. Feedback shows that the system motivated participants to engage in learning the learning

process [23]. The book named "Little feet and big feet" was developed to explore the reading experience of children. The observation study was carried out. It showed that by using AR book, children were able to interact with the system. Some design guidelines of AR book were suggested based on the study [24].

Based on the literature review in AR related work in this area, various projects had been carried out to investigate the potential of AR to support different domains and learning contexts. The potential of AR were highlighted by many researchers. Despite of the potential offered by AR technology, there is few works explore the potential of AR to support literacy, especially, learning about alphabet for young children.

3. Methodology

Based on the review on related work in exploring the literacy learning for young children, the common method used is the observation e.g. [10, 22, 23, 24]. This is due to the ability of young children to read, write and understanding. Therefore to design the experiment it is necessary to take into account the ability of young children. Therefore in this research, the observation by video recording is used to explore the interaction of young children. Besides that the simple questionnaire is used by asking children to rate how they feel about particular question based on the picture represented. The following presents the design of prototype used in this study.

3.1. The AR Alphabet Book Prototype

The AR Alphabet Book was created to enhance existing alphabet learning by utilizing an AR technology. ARToolkit software was used to develop the AR Alphabet application. Figure 1 shows the setup of the AR Alphabet Book. To view the virtual models, the user need a webcam to capture video image of the real world as well as the pattern markers and a computer monitor to display the virtual model viewed as overlaid over the pattern markers. Once the AR application is started, based on the instruction given users can use the pattern markers to display virtual objects.

Fig. 1. AR alphabet book component

The content of AR Alphabet Book comprises of two main sections. The first section is called the Alphabet Introduction section and the second is labeled as the Exercise section.

As the section title implied, the first section introduce to the users the letters of the alphabets. Each page of the AR Alphabet book (Figure 2), which corresponds to the presentation of each letter, consist of two main parts: the instruction part to guide the children or teacher on how to play and the markers placement part to put the marker. The instruction will tell the user which marker to use and the maker placement part provides a placeholder for the pattern marker.
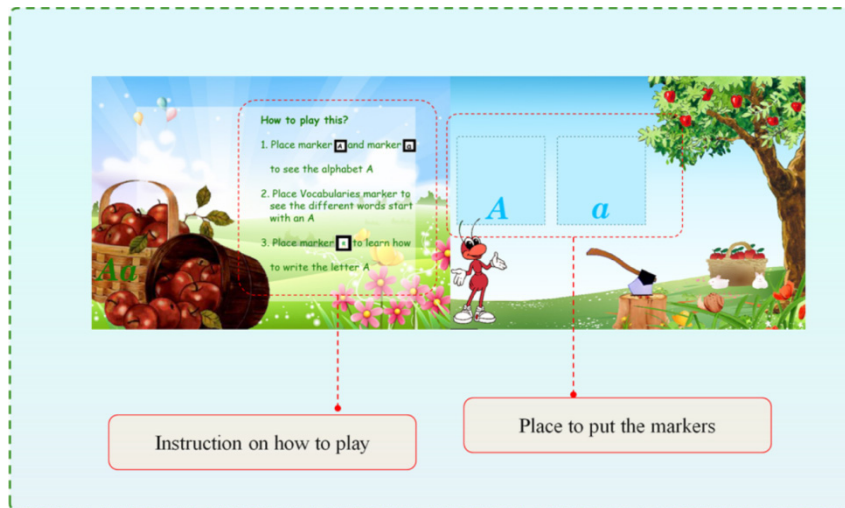

Fig. 2. The physical book content of AR alphabet book

For each letter, user will have the option to experience three modes of presentation. First, the user can view the 3D models of the uppercase and lowercase of each letter. By placing the appropriate pattern on the placeholder indicated on the book page, a model of the respective alphabet letter is displayed over pattern marker as seen via the computer monitor. For each letter two markers are provided here; one for the uppercase letter and the other for the lowercase letter.

Secondly, the user can learn simple and familiar vocabularies of words which start with the respective alphabet letter. one of the efficient way of teaching alphabet is by introduce the children with the familiar word such as if introducing A so it should be introduced by showing some example of the word start with an A such as ant, axe, apple etc. when the children get familiar with the word they can compare the letter and realize how that specific letter look like. Therefore later on, when the children saw that letter that will know how it pronounce. For each alphabet letter, a corresponding 3D model of objects is also presented. For example, for the letter "B", word such as "Banana" and its corresponding 3D model is displayed. Finally, children can learn how each letter is drawn by watching an animated view of how the letter is drawn. Each mode is initiated using a separate marker. Figure 3 illustrates screenshots taken from the augmented reality of view of some pages.

The Exercise section allows users to review what they have learned. A game approach is employed here to design this section. A simple jigsaw puzzle game is provided for student to guess a letter name. The use of pattern marker lends naturally to the design of this game. Since the target users are preschool students, a jigsaw puzzle in the form of a pattern marker is divided into only two parts. One part is provided in the book and users are required to find the right missing half of the puzzle or pattern. A correct guess will result in the display of the correct object for the letter over the complete pattern marker.

Fig. 3. The view of AR Alphabet Book prototype

4. Result and Discussion

An observational study was carried out at a preschool located in Tronoh, Malaysia to investigate users' perception towards the AR alphabet book. A class of 15 five-year old students was recruited as participants (Figure 4). Students were first introduced to the AR book application. Brief explanations on how to use the application were provided before the start of the study. Students were then allowed to freely explore the books and their actions and behavior were recorded using a video camera.

Fig. 4. 5-year old students interact with AR alphabet book

During the experiment, children were asked if they recognized the alphabet they are holding and other specific letter, most of the children answer correctly. Following the study, each student was asked to rate on five short and simple questions survey. As the participants were young children, a smiley face-based scale (Figure 5) was used as it is fun and easy to complete. For the survey, the experimenter read the question and the participant tick the appropriate column.
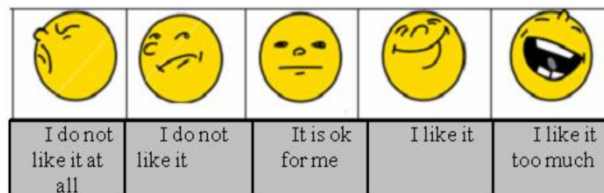

Fig. 5. Smile face used for rating the questionnaire

Figure 6 shows the result of the questionnaire. Question 1 & 2 sought participants' opinion on whether the participants enjoy using book and how much they like it respectively. For both questions, majority of the students strongly agree. Similarly for item 4 which asked the students if they want to play again, none of them disagree, all responded strongly agree and agree only. Our observation of the students' behavior confirms this. Most of the students requested to use the pattern markers repeatedly. Most of them were excited to see the virtual 3D objects appearing on top of the pattern markers. However, for item 5, when asked if they would like to have a copy of the book, only two responded no, the rest would like to have the book. One of the problem observed during the study is the square pattern marker is difficult to use for the children. Sometimes the virtual objects do not appear on the pattern marker. Due to their excitement, the students' hand obscured the pattern marker images thus preventing it from being detected by the camera. To avoid this issue, future enhancement may include a mark on the pattern marker to show the children where to hold it.
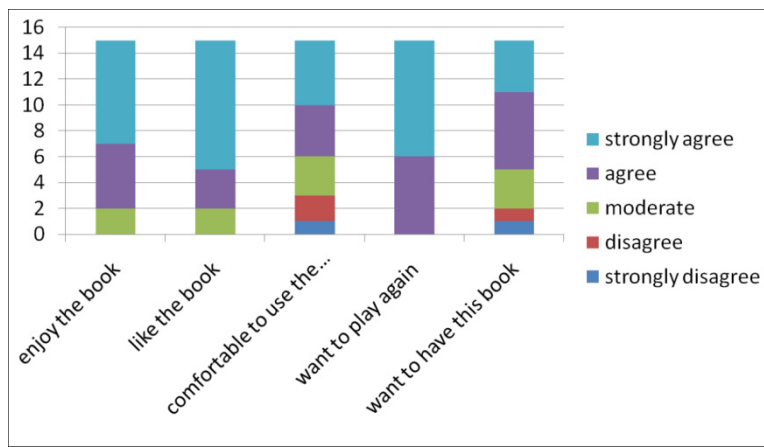

Fig. 6. Linear sequence of gaze

The results of study are consistent with findings from several researchers [13, 22, 23, 25, 26]. Our observation also reveals that the unique interface of combining real and virtual objects do acts as a natural attention grabber for the children as mentioned by many researchers e.g. [22, 23]. Most of the students like to hold the markers and watch the virtual object appear on it via computer monitor. Their facial expressions exhibit their enjoyment using the application. Their requests for using the application repeated for several times shows a positive indication that AR application could be used as a fun and engaging learning tool.

Upon the survey had been carried out, the teacher who take care of the class also observed their student. The brief interview with a teacher revealed that based on her opinion, the student seems to enjoy AR alphabet learning. They were waited for they turn to show they respective AR marker in front of the computer. Besides that, they also can identify what is the letter they are holding.

5. Conclusion

In this paper we have presented the development and evaluation of an augmented reality book for learning the alphabet. One of the advantages of an AR book over traditional book is that other interesting elements such as animation, virtual objects, sound and video can be integrated while having the physical book itself. The results of our observational study show that the presences of such features do generate excitement, engagement and enjoyment during the learning process. The results of our survey questions corroborate these findings. Our

observation also reveals that the unique interface of combining real and virtual objects do acts as a natural attention grabber as well as an engaging and fun learning tool for this age group.

Continued usage of the book may bore the reader as they can predict what objects will appear. For future work, embedding element of surprise in the application could make the application more fun and engaging. Whilst several objects were provided for each alphabet, random display of these objects and adding more objects for each letter could be another future enhancement. Similar development approach could be used to create AR book applications in other subjects such as science and mathematics. Currently, works under way in creating AR book applications for both subjects. More usability studies will be conducted using other approaches to measure element of fun and engagement in the learning process.

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