

Simple Augmented Reality (AR) for Elementary School Mathematics

Dee Jean, Ong

dee.on@ssru.ac.th

International College

Suan Sunandha Rajabhat University

Thailand

Abstract: *Augmented Reality (AR) in education is relatively new but developing rapidly. AR is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input. This work shows how AR is used for the development of a simple mathematics concept for elementary school children. A panel of two elementary educators teaching mathematics concepts was asked to validate the utility of flash cards. After revision, the flashcards were tried out on 9 elementary school students, aged 6 to 10 in an informal setting in Suphan Buri Province, Thailand. A semi-structured interview was conducted and transcribed verbatim. The flash card implementation was video-record for data interpretation. Findings showed that these activities can arouse curiosity as well as develop interest and better understanding of some mathematics concepts. Students generally demonstrated better understanding of counting and simple addition concepts by AR as their motivation and interaction increased. The AR materials are in the form of flash cards. The users have to use application software “Augment” to scan the flash cards to view the numbers appearing in 3D from the flash cards.*

1. Introduction

Augmented Reality (AR) in education is relatively new but developing rapidly. The use of AR in elementary mathematics education in elementary school classrooms can allow young children to imagine numbers and objects in a three-dimension way. Virtual Reality (VR) can be used as an educational tool to arouse learners’ curiosity and interest [3]. Azuma [2] gave a good definition of AR. AR is a variation of VR. AR allows the users to see the real world with virtual objects composited with the real world. The users can also see numbers in 3D form in flashcards when they scan the flashcards using the application software “Augment”. Students’ perceptions about their learning process indicate how they conceptualize learning in their mind [4]. Their learning experience and preference for learning influence the formation of their conceptions of learning [4]. The use of AR can help elementary school children visualize numbers in a most unique way and achieve a better understanding of simple mathematics concepts.

2. Related Work

Information technology allows us to adopt a new way of introducing mathematics education to elementary school children in the classroom and out-of-school activities [9, 10, 12]. Several studies reported that learning by AR has numerous advantages. Cheng [4] conducted a study on parents’ conceptions of AR learning and found that to a large extent, parents responded positively towards learning by AR. In another study, Cheng [5] reported that students generally exhibited positive conception of learning science by AR (CLSAR), with stronger perceptions of learning science with increased in motivation and interaction. Auliya and Munasiah [1] found learning by AR fostered students’ learning in using technology, increased their understanding of geometrical concepts for

better visualization and interaction. Learning by AR can support the social interactions amongst users in the same physical area [10].

3. Applications

Mobile phones and computer tablets become common tools in daily life. The people always use mobile phones as calculators. Information technology can enable us to develop applications on mobile phones for mathematics education purposes. In order to create 3D objects for mathematics education approaches, we need software for making 3D geometrical models and for scanning or viewing the objects.

There are numerous software applications for creating 3D objects for mathematics education in the market. These applications can run on mobile phones or on computers. In this paper I used software Autodesk Maya to create 3D geometrical objects for AR applications. This software can be purchased from personal or commercial uses from website: www.autodesk.com. There is also a student version for educational purposes only.

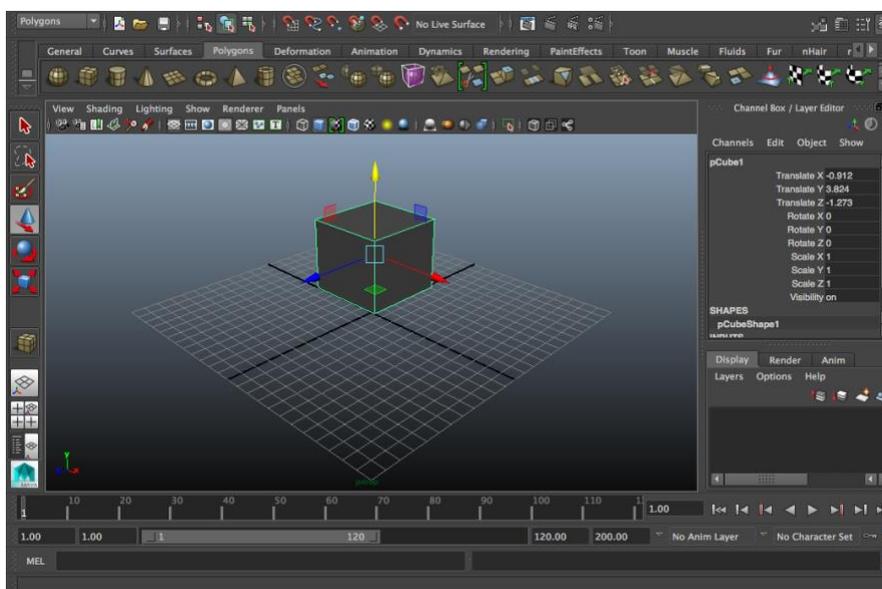


Figure 3.1 Working Screen of Autodesk Maya for Making a Model of a Cube

We have to run the programme Autodesk Maya on a computer to create a model or a figure. A type of model can be chosen by clicking a button on the model menu on the top left of the screen. The size and position can be adjusted by dragging a mouse to create the chosen model. The Figure 3.1 shows the cube model created by Autodesk Maya. After a model or a figure is created, it must be saved using an export command to store the model in a working folder. The model or a figure must be saved in the file type DAE. This model or a figure will be used to display in a 3D floating on a background in a real world.

In order to construct an AR of the model we created from Autodesk Maya, we need another software to link the model to the background or tracker. The software for Augment Reality can be purchased from <http://www.augmentedev.com/>. A student version can also be obtained for educational purposes only by contacting the software provider.



Figure 3.2 Working Screen of Augment for Making an AR Model of a Cube

In the Augment website, we can use the working utility to create the AR model of a cube as shown in Fig. 2. In order to do that, we have to transfer the figure, in this case, a cube that we save in the working folder of Autodesk Maya into the AR folder of Augment website. After uploading the cube model to the Augment folder, you will see a picture of the cube on the screen. To view the 3D cube model of AR using a mobile phone or compute tablet, you will need to scan a background picture. This background picture is called tracker.

We have to prepare a tracker so that it will be used to scan and link with the figure that we have in the model folder. A tracker can be any picture which is related to the model that we want to use to teach mathematics concepts to elementary school children. The Flashcards in the Fig.3 are used as trackers for AR of a figure number. In order to upload a tracker photo, we have to click an ADD TRACKER button on the Augment screen. The flashcard is uploaded in to the tracker folder.

For the purpose of this paper, Autodesk Maya is used to create numbers in 3D form. Simple counting and arithmetic concepts (addition within 10) are introduced here. Flashcards depicting daily life objects familiar to elementary school children are used. Each flashcard depicts a total number of objects of not more than 10 (Figure. 3.2).

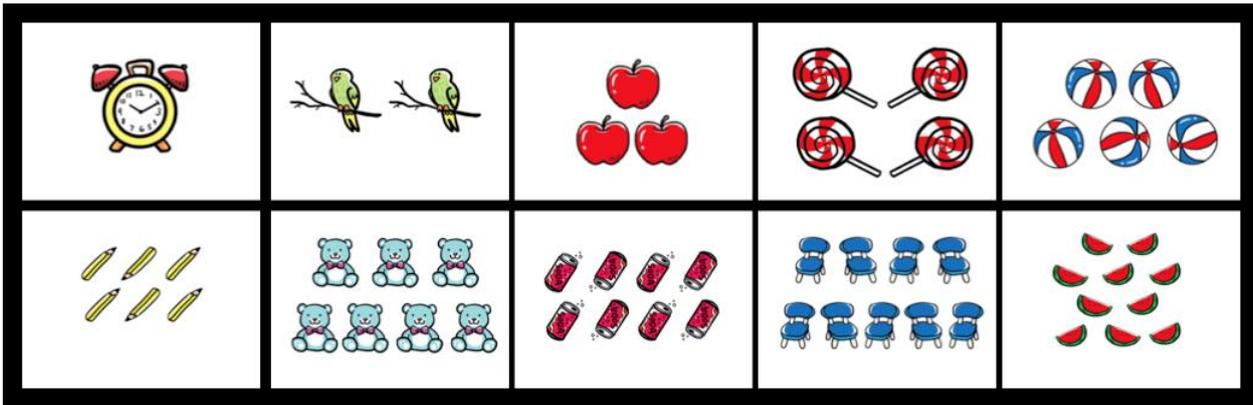


Figure 3.3 Flashcards Depicting Daily Life Objects of Not More Than 10 in Total

The next step is to construct an AR of the number model which depicts the total number of objects in each flashcard. I used another software Augment Reality to link the number model which I created from Autodesk Maya to the background of tracker (see Figure. 3.4).

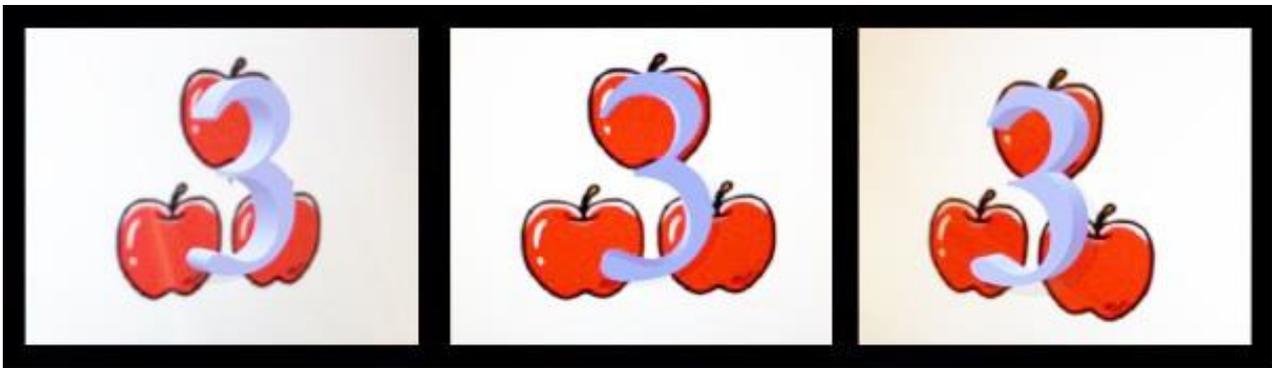


Figure 3.4 The Number Model “3” Pops Up in 3D Form

In order to view 3D number model “3” of AR, we need a background picture to be scanned. This background picture is called tracker. We also need to download an apps into a computer tablet or mobile phone to view the 3D number model “3”. This app is “AUGMENT” available for both iOS and Android. After scanning the tracker, you should see the 3D number model “3” (see Figure. 3.5).



Figure 3.5 3D model of number “3” is viewed after scanning using a mobile application “AUGMENT”

To help elementary school children learn simple addition within 10, two types of combination are introduced. Firstly, a combination of two different sets of objects are used (see Figure. 3.6).

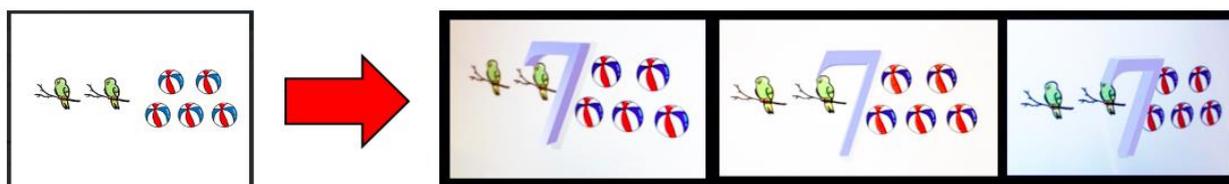


Figure 3.6 Combination of Pictures

Secondly, a combination of a picture and a number is used (see Figure.3.7).

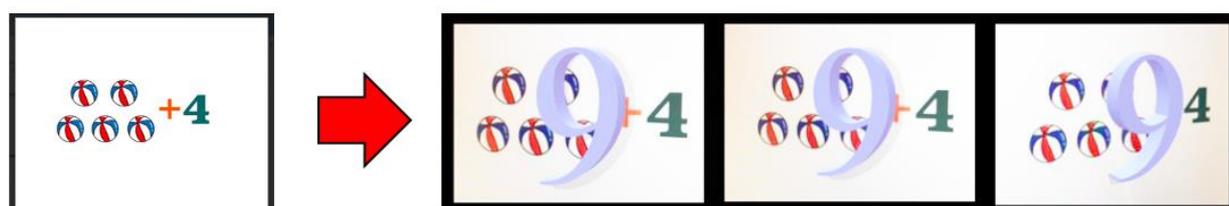


Figure 3.7 Combination of A Picture and A Number: Simple Addition Concept

After scanning with a mobile application “AUGMENT”, 3D model of the number 9 will appear and can be seen from different positions like a real object floating in the air with tracker background.

4. Method

4.1 Respondents The respondents of this study were convenient sampling. They included 2 elementary school teachers and 9 elementary school children, aged 6 to 10. Both elementary school teachers had more than 10 years of teaching mathematics in an elementary school in Thailand. None of the respondents had experience in learning by AR.

4.2 Data Collection The researchers sought approval from the school director to carry out the flashcards with the elementary school children. The researcher first conducted a semi-structured interview with the elementary teachers in an informal setting. In the informal meet up, the researcher showed the flash cards to the elementary teachers. The interview was video-recorded and data was transcribed verbatim. With permission from the school director, the researcher conducted the AR session with the elementary school children in an informal setting in Suphan Buri Province, Thailand. The learning by AR session was video-recorded for data interpretation.

5. Using Augmented Reality in the Classroom

5.1 Feedback from elementary educators Interview from elementary educators showed that the use of daily materials in the flashcards was relevant and appropriate. The flash card size and paper used were suitable for elementary school children. They suggested that with the help of AR,

elementary school teachers can arouse learning interest of elementary school children in learning simple mathematics concepts and achieve better understanding of early mathematics. It will be interesting if schools can make resources available for the teachers to explore AR and incorporate AR in the children's workbooks or worksheets, related to the contents studied. Elementary school children can use the computer tablets (either individually or in groups) to learn mathematics education independently or co-independently in a creative and fun classroom environment.

5.2 Response from elementary school children Elementary school children's responses were video-recorded and interpreted. Casual conversations were carried out to probe their understanding of elementary mathematics concepts like counting and simple addition. They had fun learning with their friends as they scanned the image and a number popped up in 3D form (see Figure. 3.4). They could count the numbers from 1 to 10 and associate the numbers to the objects in the flashcards (see Figure.3.3). For simple addition, they learnt that the sum total can be a combination of pictures (see Figure. 3.6) or combination of a picture and a number (see Figure. 3.7).

They were also able to name the daily life objects depicted in the flashcards. The elementary school children reported that the flashcards were easy to use. They also stated that they like the colorful pictures. Attractive visual elements promoted the children's learning interest [8] and engaged them in interacting with the materials as well as their peers.

6. Discussion and Conclusion

The idea of using AR to teach and learn elementary mathematics concepts in the elementary school classroom can be interesting. Elementary school children can be engaged in their learning in an interactive and creative way amongst their peers. The use of simple AR in elementary mathematics could bring about new impact and a new way of learning elementary mathematics concepts in the classrooms or even independent learning anywhere.

In this work, we can design and create our own models or number figures for mathematic AR activities. Apart from commercial software utilities, there are also options for student and teacher version to use for free. In addition, there are several commercial applications on mobile phone or computer tablet for AR. Some of the contents are mathematics with black and white pictures. Elementary school children can color the pictures and scan them after. For instance, Quiver (see Figure 6.1) brings coloring pages to life. This Augmented Reality coloring app can create engaging, immersive coloring experiences for people of all ages. This can make the classroom more interesting and meaningful.

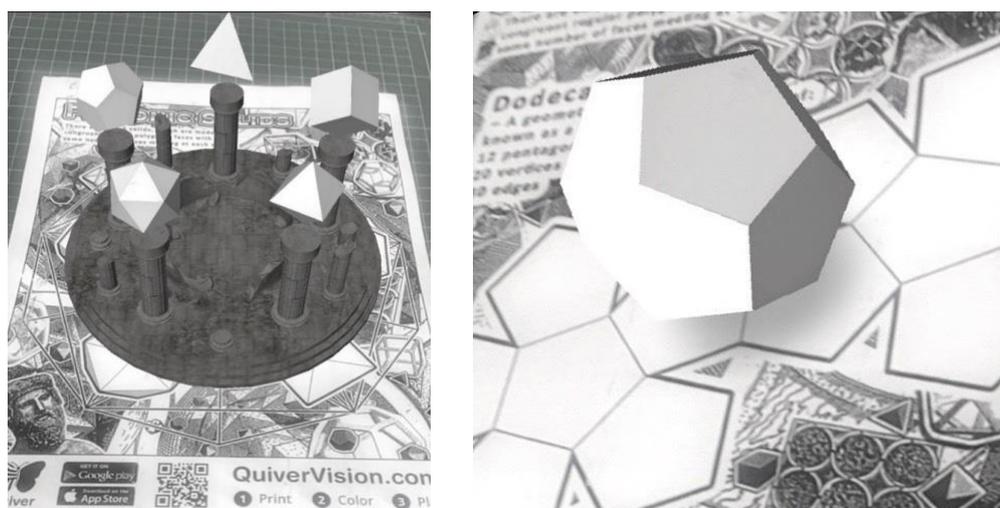


Figure 6.1 Showing Mathematic AR Models Using Quiver Applications

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