Android-based augmented reality media and the curiosity about mathematics

T D Pamungkas

Primary Education Study Program, Postgraduate Faculty, Universitas Negeri Jakarta, Indonesia

Corresponding author’s e-mail: TikaDwiPamungkas_9918819010@mhs.unj.ac.id

Abstract. The rapid development of technology has changed the paradigm of education, especially when technology is combined pedagogically, creating new opportunities to improve the quality of teaching and learning. One of the opportunities to improve the quality of teaching and learning is the use of Augmented Reality. Augmented Reality technology attracts student motivation and curiosity so that students are more active, creative, and have high enthusiasm for learning, specifically mathematics. This study reviews some of the literature regarding information about mobile augmented reality and its implementation in increasing students’ curiosity about mathematics.

1. Introduction

Infants and children have the motivation to learn from natural curiosity, driven by the desire to interact, know, and understand their surroundings [1]. This curiosity is what teachers need to develop and facilitate. However, there are still conditions where the learning process is teacher-centered. In an effort to build student curiosity, students must be encouraged to be active in finding their curiosity.

Learning with multimedia can activate students to learn with high motivation because of their interest in multimedia systems that are capable of presenting text, images, video, sound, and animation displays [2]. This statement shows that students can be enthusiastic about learning with interactive multimedia because it looks attractive and supports learning.

There are three aspects contained in the curiosity of students. The first aspect is the desire to interact, and the word interaction means interrelated. So interacting can be interpreted as an activity to establish a relationship, so the desire to interact is the desire to have a relationship [3]. The second aspect is the desire to know. The word to know comes from the basic word to know, which starts with me. To know is to know, so knowing can be interpreted as knowing [3]. The third aspect is the desire to understand. The word understands itself is related to an understanding.

Basically, the traditional educational method is carried out through direct instruction in which all learning and knowledge activities are regulated and conveyed by the teacher [4]. Although sometimes, these existing methods work effectively, there are more effective methods to increase the interest of educators and researchers in the teaching and learning experience [5]. As technology has expanded in recent years, integrating technology and educational pedagogy has influenced and revolutionized the way we teach and learn. Teaching and learning that is transformed due to technology certainly provide
interesting opportunities to design learning environments that are realistic, authentic, interesting, and very enjoyable [5].

The role of technology is to increase student involvement in understanding learning material [6]. Many technologies have been integrated into education, including the use of computers, multimedia, the internet, e-learning, social networking, simulations, and more recently mobile devices and immersive environments such as games, virtual worlds, and augmented reality. Augmented Reality (AR) is a technology that has the potential and impact on the learning process. In addition, the expanding ownership of mobile devices has led to increased interest in integrating the benefits of device learning via mobile devices and augmented reality applications.

Ari Nugroho N and Ramadhani A [7] conducted research applying Android-based AR technology for the introduction of space shapes with 3-dimensional views. In learning, especially mathematics, AR is usually used to display objects or images in a 3-dimensional form so that their appearance appears real-time and real. The development of AR technology that will be carried out in developing the AR display from 3-dimensional images to animated videos, the output displayed will be more attractive and more interactive because, in the application, there are moving audio and video.

2. Methods
Data in this article were collected using the literature review method. The literature review can be in the form of combining literature, setting then up into a series of interrelated topics, and summarizing them by showing the central issues. In this article, the literature review method aims to collect all relevant information from the written documents such as journals and books published in 2002-2017. Documents are tracked by websites such as google scholar, SpringerLink, and ScienceDirect. This reviewed seven articles and books with keywords of “competencies of the 21st century” and “mathematical literacy competencies”.

3. Result and discussion
3.1. Augmented reality
The development and application of technology are currently increasing rapidly, including in the fields of science and education. Technology-based learning systems have also begun to be implemented. One of the object visualization technologies currently being utilized is augmented reality technology. The definition of augmented reality is combining real objects and virtual objects interactively in real-time [8], and there is an integration between objects in three dimensions, namely virtual objects integrated with the real world. [9] Augmented reality is an application that combines the real world with the virtual world in two-dimensional and three-dimensional forms, which are projected in real environment at the same time. Augmented reality is the incorporation of virtual objects (two dimensions or three dimensions) into the real environment through technology, then projecting these virtual objects at the same time. There are three characteristics of AR [10], namely: 1) Combining reality and virtual objects in a 3D real environment; 2) Runs interactively and in real-time; 3) integrating objects in three dimensions, namely virtual objects integrated with the real world.

AR can also turn abstract concepts into visual presentations of objects or phenomena to enhance learning [11]. Augmented reality works using computer vision techniques and pattern recognition techniques. The computer vision technique is a technique used by the system to look for cards (markers) [9]. Augmented reality is the projection of material produced by computer processing, such as writing, images, and videos, into the human perspective in the real world [12]. In simple terms, augmented reality can be interpreted as the addition of virtual objects to real objects at the same time, so that the two objects seem to merge. Augmented reality also encourages constructivist strategies [13]. Several studies use AR technology to support the collaborative learning process by providing knowledge-sharing features and the use of different roles [14].

AR-based learning allows students to build course knowledge structures by drawing digital links that connect real images that represent the main concepts to be learned [15]. So, Android-based
learning media using Augmented Reality (AR) technology, the learning process becomes more interesting because it uses three-dimensional objects so that children no longer need to imagine these objects and users can directly interact, so the learning process becomes more interesting [9].

The teaching aids using the AR system are easier to understand than conventional props, through these props students seem to be faced with a real learning object so that the teaching and learning process is more enjoyable, even props with the Augmented Reality system can help students to understand the material with easy [16]. Previous research showed that augmented reality creates an authentic learning environment suitable for various learning styles that have a positive influence [17]. In line with that, augmented reality is widely used on US campuses as a technology that combines two worlds, namely virtual and real, that AR has enormous potential implications and benefits for augmentation teaching and the learning environment [18].

Learning media with the use of augmented reality is an intermediary between educators and students in learning that is able to connect, provide information, and convey messages so as to create an effective and efficient learning process. Learning media results in communication between educators and students in the learning process. Learning media augmented reality can visualize abstract concepts for understanding, and the structure of an object model allows AR as an effective medium in accordance with the objectives of learning media [19]. If the learning process does not use media, the learning process will not occur.

Previously, there have been many studies on AR. Augmented reality technology has a positive impact on learning outcomes related to Mexican high school students [13]. Students who use augmented reality-based learning media score higher on post-test than using web-based applications as well as augmented reality technology, can be used as an effective learning medium to help middle school students from public and private schools.

AR affects the conceptions and approaches of junior high school students to learn mathematics with various levels of self-efficacy [20]. It was found that students in the high self-efficacy group achieved higher scores in the application conception of understanding and ways of thinking than those in the low self-efficacy group.

In other research found that the use of interactive AR learning media can be connected to life experiences that are displayed in real-time 3D with a problem-solving approach that can encourage students to make connections between their knowledge and applications in their lives [21]. This is in line with the opinion [22], which concluded that AR technology provides concepts in interactive 3D simulations that lead to deeper insights and increased understanding [22].

Chen [23] in his research emphasized that students who use mobile AR have higher learning motivation, better performance, and can reduce anxiety in learning than those who do not use mobile AR, because students think mobile AR application systems are useful, fun, and easy to use.

Squire K and Klopf E [24] synthesize that AR in the form of a game can stimulate prior knowledge of students and increase the level of student involvement in academic activities. In addition, AR can also increase collaboration between students and also student-instructors as a result of maximizing the transfer of learning. Moreover, in the study [6], AR technology has also shown a positive impact on the motivation of middle school students. It is proven that the AR environment can increase students’ motivation and interest, which in turn can help them develop a better understanding of learning content.

3.2. Curiosity development with AR

In implementing AR media, the focus is more on using source tools such as Unity 7 as the main framework for building AR applications. The process flow of the AR application to be developed can be seen in flowchart figure 1. The first stage is with a splash screen, select the menu, then select the AR camera. In the AR camera menu, there is a download marker menu, a menu about to find out information about the application used, and the exit menu to close the application. In the next stage, in the AR Camera menu, then AR wakes up space. In the next process, the application will read, “is there a marker?.” If there is a marker, the application will detect the marker. After the marker is detected,
the application will display a space building object. In the building menu, there is a menu option “Definition” which will display the definition of the shape. The “Net” menu displays the shape animation. The “example” menu shows how to solve the problem. The “formula” menu displays the shape formulas. Each menu that is used can return to the “AR Build Space” menu.

Figure 1. Flowchart of AR application in learning to build space.

Figure 2 shows a use case diagram design in an AR application. Users only need to point the camera at their laptop or Android cellphone, then the object marker is directed in front of the camera. If the marker position is precise/focused, the 3D object will appear on the screen, followed by a sound clue according to the marker object selected by the user.
The marker design offered is a Magic Book, in which a collection of several designed markers is stored in one textbook for teachers and parents (users). The design of this magic book includes an explanation of the character of the marker object. For example, for animal characters, the type of eating of the object is displayed. In magic book design, besides being used as a marker for AR applications, it can also be used as a medium for building space-building networks for users. Another feature of this AR application is that users can rotate 360 3D objects so that users can observe 3D objects in detail. Some spatial shapes will be displayed in the form of animated videos, so the learning atmosphere will be very interesting.

The use of interactive multimedia to hone students’ curiosity is by explaining learning objectives to students, then explaining the use of interactive multimedia that students can use as a form of learning interaction. Through this initial explanation, students know the learning to be passed, so students can interact with other students and teachers to discuss further learning. The main purpose of this first stage is not only to invite students to learn but to teach students to find information independently through the use of interactive multimedia. Through the use of interactive multimedia, students have sharpened their curiosity skills by asking students to collect information related to learning so that students will ask questions about what was learned. Appropriate interactive-based learning media will greatly play a role in the creation of educational goals, one of which is to build a character of curiosity.

Curiosity can be obtained by always asking questions and finding out not only from the teacher but from peers as well. In line with the opinion that the existence of media will arouse students’ curiosity to learn so that students’ curiosity can be interpreted as a desire to interact, know and understand something that is around them. The next stage of using interactive multimedia organizes students to study or research problems, then the teacher guides in individual and group investigation activities. Then interactive multimedia displays question exercises and asks students to collect appropriate information and solve questions to solve problems that are displayed in interactive multimedia. At this stage, the teacher invites students to work together to solve problems that are displayed in interactive multimedia. After curiosity has been sharpened in the first stage, then it is sharpened again in order to investigate a problem contained in the question. At this stage, it requires students to work together between students, explain, make solutions. Students are given the opportunity to provide questions and opinions so that at this stage, the student’s curiosity is sharpened again. Based on the stages carried out in the use of interactive multimedia, students’ curiosity abilities can be developed properly.

4. Conclusion
Based on the description, it can be concluded that the steps of using multimedia to hone students’ curiosity abilities are 1) explaining learning objectives to students, followed by explaining the use of
interactive multimedia that students can use as a form of learning interaction, and 2) organizing students to study or research and solve problems followed by the teacher guiding them in individual and group investigation activities; 3) Through the use of multimedia, students’ curiosity can be honed and developed properly.

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