Prototyping the Augmented Reality as Learning Media on Global Warming Issue

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Abstract. This learning media was developed to meet learning objectives, especially understanding Global Warming in seventh-grade students. It is an interactive one in the form of AR (Augmented Reality). Various menus and content in comics and AR are arranged in simple language and set of daily events. The AR phenomenon can encourage students to think critically to understand the issue of Global Warming. The validation carried out by media experts and material experts stated that this media is suitable. In addition, user responses (seventh-grade students) were also positive on several eligibility criteria. Some of the advantages of this application are that the file size is not too large and can be embedded on an Android-based smartphone, so it can be played even if there is no internet network. The follow-up to the use of this media is how effective this media to increase the motivation learning and students' critical thinking skills.

Keywords: augmented reality; education; learning media

1 Introduction

The PISA (Program for International Student Assessment) assessment results show that Indonesia always gets a score below the average score of 371. In science subjects, Indonesia ranks 38th out of 41 participating countries (in 2000), 38 out of 40 participating countries (in 2003), 50th out of 57 countries (2006), ranked 60th out of 65 countries (2009), and ranked 64th out of 65 participating countries (in 2012). This result is a concern for the Indonesian government to improve the education process [1]. The current progress of science and technology is in parallel with the educational foundation that encourages good scientific literacy in schools [2]. The use of technology in learning is one alternative to improve the level of scientific literacy. In today's era, the role of digital technology such as augmented reality (AR) is significant [3]. The teacher can use AR to support the achievement of better learning objectives. AR is a digital technology that can combine virtual objects in two or three dimensions with a natural environment and then bring them up or project them in real-time [4].

The opportunities for using AR are the basis for making prototypes of physics comics used for specific materials. In Indonesia, with a wide distribution of schools where some schools do not have good internet access [5], the development of AR embedded in cellphones is necessary for these students. In addition, AR is expected to provide an overview of a phenomenon that does not always exist where students are located, one of which is the phenomenon of global warming. With these various learning needs, not enough AR applications are available to

support successful learning. So the purpose of this research is to develop an AR application integrated with comics and global warming issues. With AR-assisted comics as a learning medium using 3D digital technology, the delivery of global warming materials will be easier to visualize and more enjoyable.

Theoretical Background
Comics for Learning
There are three ways to integrate art in learning: learning through art, learning about the skills, learning with the arts, and learning through the arts. People often interpret comics as picture stories. Comics can mean juxtaposed (nearby, side by side) images and other symbols in a particular order to convey information and/or achieve an aesthetic response from the reader. Comics are more than just light and entertaining picture stories [6,7]. A comic is a form of visual communication media that can convey information in a popular and easy to understand manner. It is possible because comics combine the power of images and writing arranged in a storyline; pictures make information more easily absorbed [8]. As a visual communication medium, comics can be applied as educational aids and convey information effectively and efficiently. Learning styles consist of visual styles, auditory styles, and typing styles [6-8].

Augmented Reality in Learning
AR is a concept of combining the virtual world with the natural world to generate information from data taken from a system on a designated real object so that the boundary between the two becomes increasingly thin [3,9]. There are three characteristics that state that technology applies the AR concept: able to combine the natural world and virtual world, able to provide interactive and real-time information, and able to display in three-dimensional form. The teacher can use AR to visualize abstract concepts for understanding and structuring an object model [10]. Currently, AR is widely used in gaming, medicine, and image processing, while in the field of education, it is still rarely used.

Science Literacy
According to PISA 2006, scientific literacy is the ability to use scientific knowledge to identify problems and draw conclusions based on evidence to understand and make decisions about science and the changes made to science through human activities [11]. PISA also assesses students' understanding of the characteristics of science as a scientific inquiry, awareness of how science and technology shape the material, intellectual and cultural environment, and the desire to engage in science-related issues as reflective human beings [12]. Aspects measured in the scientific literacy assessment include the knowledge of science, the investigative nature of science, science as a way of thinking, and interaction of science, technology, and society.

Global warming
Global warming is one of the leading environmental issues facing the world today. Global warming is related to the process of increasing the average temperature of the earth's surface. This increase in the earth's surface temperature is produced by solar radiation in the earth's atmosphere, then some of this light turns into heat energy in the form of infrared rays, which are absorbed by the air and the earth's surface. One of the causes of global warming is the greenhouse effect. In greenhouses used in cultivation, especially in countries experiencing winter, or experimental plants in biology and agriculture, solar energy (heat) that enters through

the glass roof is partly reflected out of the atmosphere, and some are trapped in the greenhouse, thereby increasing temperature in it. This issue is important to be understood by student [13].

2 Research Methods

This research is a type of development research with learning media products in AR-assisted comic applications to explain the phenomenon of global warming. The resulting application is named KOFIN (Komik Physics Nusantara), which can be used mainly for junior high school students. Media experts carry out the validity of the learning media, and material experts use a questionnaire. The questionnaire used is based on a Likert scale in the form of a scale of approval or rejection of a question or statement (5: very good, 4: good, 3: enough, 2: not good, 1: very not good). The results of this questionnaire are processed based on the percentage of the value of all items. This percentage is transformed into the eligibility criteria. Learning media is declared valid if it is in the very feasible or feasible measures. Learning media improved based on expert input were used for testing on a small group of users. Measurement of response using two kinds of ways, namely questionnaires and interviews. Respondents involved in the user trial were five seventh-grade students of SMP Negeri 2 Sukaresmi, Banten, Indonesia.

3 Results and Discussion

Products

The resulting comics encourage the ability to understand knowledge and reason about natural phenomena using relevant theories. This competence is relevant to the sicence literacy [11]. The fundamental competencies achieved are analyzing climate change and its impact on ecosystems and writing ideas about tackling the problem of global warming. The indicators measured can explain the definition, causes, and effects and describe efforts to encounter the global warming [14]. Design is a design in the form of an initial storyboard using a sketch. The initial storyboard (a sketch) design is then made into a comic using Clip Studio Paint, as shown in Fig. 1.
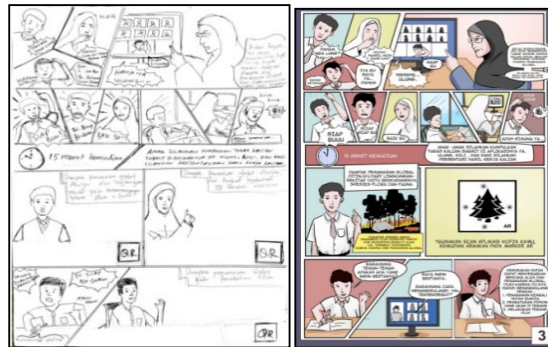

Fig.1. The design of the storyboard and the final results by incorporating AR marker elements

Expert Validation

The next stage is validating material experts (2 people) and media experts (3 people). After several improvements on the advice of experts, this learning media was declared feasible (97.5% of material experts; 98% of media experts). In terms of media quality, this media is communicative, interactive, and easy to use. Meanwhile, in terms of material, this media content follows the learning objectives, is easy to understand, coherent in delivery, and motivates learning. These results are similar to the use of AR for different materials [15].

User Interaction

Students scanned the AR markers in the comics using an application installed on an Android-based smartphone with a display. This application is effortless [15]. There are only three menus: Scan to activate the marker, How to play to explain how to use it and Quit to exit the application. With this simple menu, users will not be bothered in using this app. In addition, this application is embedded in smartphones, so students can still use it when there is no internet network.

The stories used in the comics were made in simple language in the form of everyday conversations at school. In this way, students can feel involved in the dialogue that is on commit. This technique is also used in other research with the aim of making it easier to understand the teaching material [16]. AR markers are installed in scenes where students need to make observations or observations related to certain phenomena. When they see the 3D video that appears, they will discuss to understand the material and explain the phenomenon's occurrence. An example is in Fig. 2 that students are expected to explain the impact of global warming. On that page, markers are presented to be scanned related to the effect of global warming.

Scanning the marker will bring up the global warming phenomenon following the learning objectives. Fig. 3 shows the video that appears as an AR phenomenon in the form of a 3D video. With a simple design and focus on core concepts and theories about global warming, students have a learning experience. In this video, students can repeat, move markers, and see from various directions to show interest in this material.

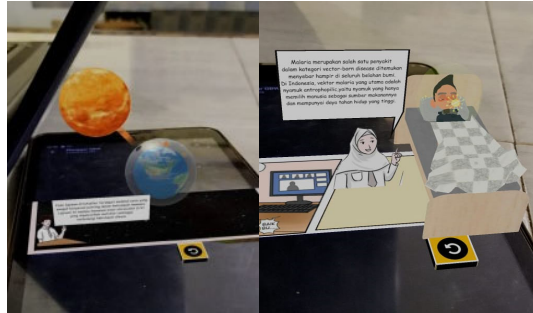**Fig.2.** The sample of the dialogues related to marker.

Fig.3. Display of 3D phenomena appearing from AR.

Student Response

In interviews with users (students) after they used comics and their applications, they generally gave a positive response. Fig. 4 shows the results of student responses related to AR media. This discussion does not explicitly include reactions to the comic display.
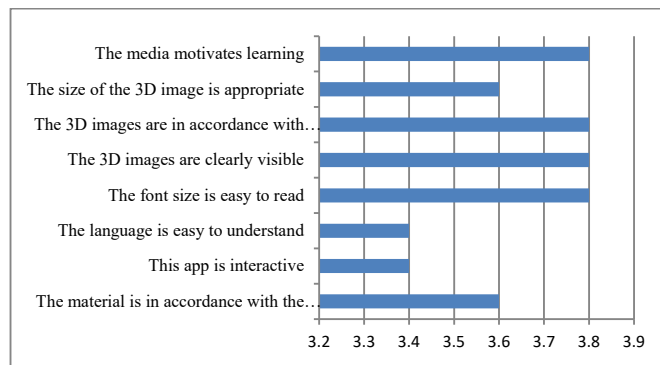

Fig.4. User responses related to 3D phenomena in AR.

Figure 5 shows that on all items, students gave a high response (above 3.0). These results indicate that AR as a learning media has a match with the characteristics of students. In addition, these results show a high potential in the use of AR-assisted comics for competitive learning as well as supporting similar research [4,9,15].

4 Conclusion

The selection of the issue of global warming is essential to build students' awareness of the common problem. The provision of accessible, interactive, and communicative AR-based applications can encourage the growth of interest in understanding the material well. This AR is also supported by a simple application to scan markers to easy to operate. The 3D phenomenon displayed is in the form of a video and is explained in text form so that users immediately know the explanation of the phenomenon and be given a thought trigger contained in the comic. The excellent response from users shows that this media has the potential to be

used in science learning. However, the teacher needs to select suitable learning strategies for using this AR-assisted comic.

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