

DEVELOPMENT OF AUGMENTED REALITY (AR) LEARNING MEDIA OF NATURAL SCIENCE SUBJECT ON SUBJECT MATTER OF WATER CYCLE FOR MI GRADE V STUDENTS

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Abstract

This development research aims to: (1) produce the learning medium of Augmented Reality (AR) on natural science subject on subject water recycle in class V MI Wahid Hasyim; (2) knowing the quality of the products the learning medium of Augmented Reality (AR) on natural science subject on the subject matter of water recycle ; (3) find out the results of the response of teachers and students so that decent media used in learning natural science. The development model used in this medium is the modified Thiagarajan 4D model. The stages carried out consist of three stages, namely Define (defining), Design (design), and Develop (development). The media for learning Augmented Reality (AR) was assessed by 1 media expert, 1 matter expert, 1 peer reviewer, 1 class V teacher, and 10 V grade students MI Wahid Hasyim to find out student responses. The instruments used were questionnaires and evaluation sheets using non-objective description forms for testing the quality of science learning media products. The results of the study are: (1) Augmented Reality (AR) media learning products have been developed for water cycle matter run on Android version 4.1 jelly bean, (2) Learning media for Augmented Reality (AR) water cycle matter with feasibility according to the overall assessment of reviewers and peers reviewers obtain very good quality ie 90.2%, (3) response or response of class V teachers is very good with a percentage of 82.57%. Likewise, the students' responses obtained a percentage of 90.2% with a positive response so that the learning media had a quality category on the Very Good criteria which was also supported by the results of students who experienced an increase of 35.8%. Based on the results of data acquisition shows that the learning

media of Augmented Reality (AR) on natural science subjects water cycle matter in class V MI Wahid Hasyim is worthy of being used as a learning resource for students.

Keywords: Augmented Reality, Learning Media, Development Research

INTRODUCTION

In this era of globalization requires us to carry out activities as effectively as possible so that the role of technology is needed as one of the supporting activities, especially in the field of education. Indonesia in the development of technology in the world based on the International Telecommunication Union (ITU) institution in ranking the ICT Development Index (IDI) ranks 108 out of 167 countries in the world. While based on the research of the Ministry of Communication and Information of the Republic of Indonesia and UNESCO in 2014, at least 30 million children and adolescents in Indonesia are internet users, and digital media is currently the main choice of communication channels they use. The study found that 80 percent of respondents surveyed were internet users, with evidence of a strong digital divide between those living in urban areas and more prosperous in Indonesia, with those living in rural (and less prosperous) areas. In the Special Region of Yogyakarta, Jakarta, and Banten, for example, almost all respondents are internet users. While in North Maluku and West Papua, less than one-third of the respondents have used the internet (Broto, 2017).

In line with the development of information technology, educational institutions began to innovate in teaching and learning activities. Innovation is needed in the world of education because with the presence of these innovations the quality of education can be improved. Teaching and learning activities in each education unit are expected to lead to a technological basis (Broto, 2017). The technology of Augmented Reality is a system that is unique in the field of information technology. Augmented Reality (AR) is a synthesis of the parable of the real and the virtual (Atmajaya & Dedy, 2017: 228). AR applications have been

applied in various fields of life, where AR is used as an application concept that combines the physical world (real object) with the digital world, without changing the shape of the physical object. Introduction of objects (text and images) used to display various information about the object. Augmented reality as a cognitive system and able to fully understand the perceptions of the user. (Boud & Haniff, 1999: 32-36).

MI Wahid Hasyim is one of the elementary school which is located in Yogyakarta, Sleman Regency area. The school system has Wahid Hasyim MI learning using instructional media books or 2D images and videos. This certainly makes the students bored in following lessons and even in understanding learning is still difficult. System or a new way of learning students at madrasah ibtidaiyah noteworthy, considering the student's MI still belongs to the ages of the children who always loved new things.

Although currently at MI Wahid Hasyim has used teaching aids to teach students such as 2D images and videos and so on, it is not impossible to introduce other technologies as learning tools for students. The interactive learning system that utilizes Augmented Reality (AR) learning media technology has never been used in MI Wahid Hasyim so this is a new thing for MI Wahid Hasyim students.

The water cycle is one of the natural science lessons taught at MI Wahid Hasyim. But now, as explained above, the delivery of this subject matter is still through books or 2D images and videos so that students tend to be passive and lead to saturation in learning. Although already using learning media, but learning media such as 2D images are not following the criteria of good learning media, including Less practical, flexible, resilience, effectiveness, and efficiency. Based on these opinions it is known that 2D images in terms of flexibility are still lacking because they can only be seen from one side and students cannot interact with images etc.

Whereas in technology-based learning media Augmented Reality (AR) stored in .apk files, in terms of good flexibility because students can interact and be able to see 3D objects that can be enlarged, minimized, and even rotated to suit existing needs. Not only that, but learning media that are made is also capable of displaying the decline of rain and evaporation in real-time and there are many more advantages that this Augmented Reality (AR) learning media has on water cycle matters. When viewed from a practical point of view, the learning media of Augmented Reality (AR) is more practical because it is easy to carry and able to get learning not only see 3D objects but there are buttons for matter and 3D objects, where technology is designed to provide services to educators who less like to read and students who have active characters. Then in terms of 2D image learning, students are easily bored and lack concentration and make it difficult to understand the water cycle matter.

So the research of Augmented Reality (AR) learning media is very important because learning by displaying 3D objects and animation through the use of technology being developed is expected that students can understand the matter well, one of them is using Augmented Reality (AR). This technology maybe for some people still sound foreign but also some people are accustomed to seeing the learning media this, so in designing Augmented Reality (AR) learning media featuring new features so that they are unique compared to existing media. In general this technology, the application is developed on desktop PCs, but as technology advances many applications that adopt Augmented Reality (AR) technology into a smartphone application.

Augmented Reality is the concept of combining the virtual world into the real world. The creation of the virtual world is done to generate user perceptions to understand information from recognized objects. The application of Augmented Reality (AR) enhances the experience of real space collaboration. Through

Augmented Reality learning media, water cycle matter is expected to be able to improve the learning process and facilitate users' understanding of the context of natural objects and connect them to every physical detail of natural phenomena and supporting cycles, especially appreciative of the details of the water cycle system from the beginning to the rain. This method practically enhances understanding of the water cycle. The need for visualization and interaction that is commonly done in various scientific disciplines can be optimized by applying the Augmented Reality (AR) technology that is in the trend. Based on the background, the researchers plan to the development of augmented reality (AR) learning media of natural science subject on the subject matter of the water cycle for MI grade V students.

RESEARCH METHOD

This research method is Research and Development (R & D), which is used to produce certain products, or improve existing products and proceed with testing the effectiveness of these products (Sugiyono, 2009: 297). The products developed are Learning Media for Augmented Reality (AR) Natural Science Subjects. The development model is procedural, which is a descriptive model and shows the steps that must be followed to produce a product (Tim Puslitjaknov, 2008: 8). The development procedure used in this research is to follow the 4-D model (Define, Design, Develop, and Disseminate), but the stage is limited only until the Development stage of the limited trial.

RESEARCH RESULTS

The results of this study are in the form of learning media specifically designed to run on mobile phones. This learning media is more focused on student independent learning. The results of media development are packaged in the form of a master application that has the extension ".APK" (application package) file which is then used to install the application on the android mobile. AR learning

media applications are presented in several menu options including AR camera menu and AR video menu. Each menu has its function to make it easier for students to learn independently.

The AR camera menu contains 3-dimensional objects that can be used by students to see the water cycle and also an audio menu to listen to the explanation of the water cycle that has been adjusted to 3D objects. 3D objects are also able to be enlarged, reduced, and rotated to provide comfort in observing the water cycle, 3D objects also display rain and evaporation in real-time. AR Menu Video contains an animation of water cycle explanations where the programming is Augmented Reality (AR) video playback. On the appearance of the video, it is given some convenience to see, namely by zooming in and out according to the needs. has a menu that is easy to operate.

The procedure for developing Augmented Reality (AR) learning media uses a 4D model consisting of Define, Design, Develop, and Disseminate. The Disseminate stage is not carried out by the developer due to time and ability limitations. The procedure for developing Augmented Reality (AR) learning media for water cycle matter is carried out as follows:

Define

Define stage consists of the preliminary analysis phase, student character analysis, curriculum analysis, and matter analysis. The initial - final analysis aims to identify fundamental problems that cause the need to develop learning devices. The basic problem that needs to be addressed is the limitation of water cycle learning media in terms of the flexibility and reliability of the devices used and the rapid development of mobile technology, especially mobile phones. The next stage is the analysis of the characteristics of students who aim to know the level of cognitive development of students. Grade V elementary school students have an age of around 9/10 years. According to Piaget's theory, elementary students are at

the stage of concrete operational development. Children think based on real or concrete experience, so they cannot think like imagining how a water cycle process occurs. However, the ability to do addition, reduction, shrinkage, and classification has developed with simple multiplication and division. The ability to think a little abstractly always must be preceded by concrete experiences. Elementary school children still need concrete objects to help develop their intellectual abilities.

Curriculum analysis is conducted to provide subject matter that will be developed on AR learning media because not all subject matter may be suitable to be developed on AR learning media. Another factor taken into consideration is the result of the percentage of students' mastery of science matter and also based on consideration of the lack of media in the science field recommended by the teacher concerned. From the various considerations, the results of the following curriculum analysis are obtained:

1. Core Competence

CC 3: Understanding factual knowledge by observing, and trying to ask questions based on curiosity about him, God's creatures and their activities, and objects found at home, at school, and the playground.

CC 4: Presenting factual knowledge in a clear, systematic, and logical language, and critical in aesthetic works, in movements that reflect healthy children, and in actions that reflect the behavior of children of faith and morality.

2. Basic Competencies

1.6. Describe the water cycle and its impact on events on earth and the survival of living things

Based on the CC BC above, it is formulated as a form of concentration of research for the development of learning media, namely as follows:

3. Indicator

a. Describe the water cycle process.

- b. Draw a water cycle process (the occurrence of rain).
4. Learning Objectives
- a. Describe the water cycle process.
 - b. Describe the water cycle process (occurrence of rain).

Then the matter analysis is done so that the matter presented in this study is following the curriculum in terms of the presentation of the matter that has been focused and so that learning looks systematic. Then produce the matter packaged in the chart as follows:

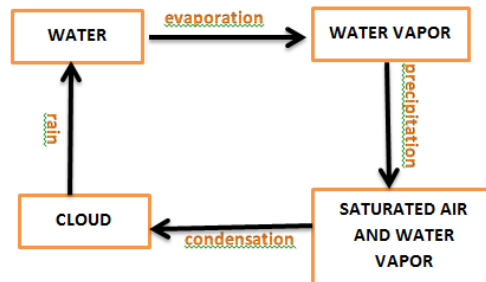


Figure 4. The water cycle

Design

The design phase of the AR media prototype. The design phase includes the design of 3D objects, design of marker making, design of building applications that consist of: Interface design, and AR menu design. The design carried out has easy criteria for hand operation, attractive design, and simple, relevant, and continuous use. The design requires software, hardware, and characteristics of the software users. The following devices are needed:

1. Hardware requirements used in building the system
 - a. Laptop Aspire E1-410 with Processor Intel(R) Celeron(R) CPU N2820 @ 2.13GHz (2 CPUs), ~2.1GHz

- b. Capacity utilization RAM 2048 MB
 - c. Hard disk with a capacity of 500 GB
 - d. Camera or webcam 2 Mb Pixel
 - e. Graphic Card (VGA) Intel(R) HD Graphics
2. Software requirements used in building system
 - a. Sistem Operasi Windows Pro 10 Ultimate 64 bit
 - b. Unity 3D 5.6.1f1 64 bit
 - c. Autodesk 3DS Max 2014 64 bit
 - d. CorelDraw X5 64 bit
 - e. Android SDK Windows version 5.0
 3. Minimum hardware and software requirements used to run the system
 - a. Smartphone with an operating system of at least Android 4.1 jelly bean.
 - b. Smartphone camera at least 2 Mb Pixel.
 - c. After the preparation, the design is carried out as follows:
 4. Design 3D

The 3D design for application this water cycle augmented reality learning uses 3DS Max software, where the 3DS Max file that has been designed is exported into a file with the extension * .bbx, to simplify the process of importing to unity. The following is a design picture of a water cycle 3D object.

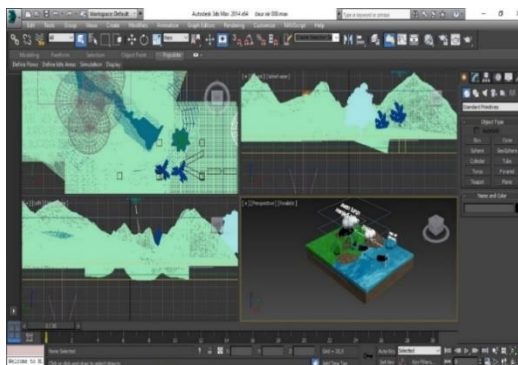


Figure 5. Water Cycle 3D Object Design

5. Design of Marker Making

The markerless marker is a type of marker used in the application of the water cycle augmented reality learning media. That is, this marker is designed according to the wishes of the author. After the marker to be used is following the requirements, then the next step is to upload the marker image to the vuforia developer which also becomes the database for the marker we will use. When uploading, the system in Vuforia automatically tracks the image on the uploaded image. This image that has been recognized by the system in vuforia will be a marker for augmented reality applications. The following is a picture of the Database Marker in Vuforia

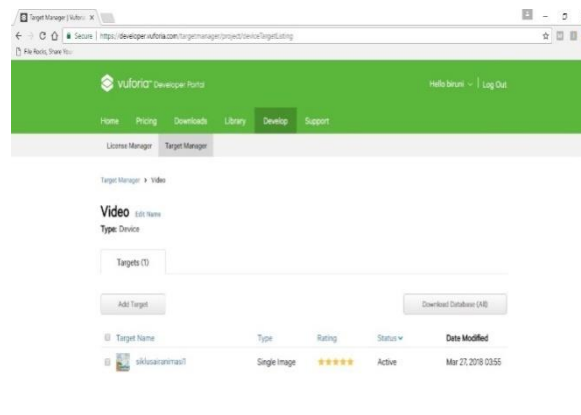


Figure 6. Database Marker in Vuforia

Develop

At this stage, the AR learning media products produced are first tested for quality before being tested on students. This quality test is carried out by reviewers and peer reviewers. Assessment is carried out by 1 media expert, 1 matter expert, 1 peer reviewer, and 1 class teacher. Reviewers have competition in their respective fields and peer reviewers are chosen by colleagues who meet the qualifications set by the developer so that reviewers and peer reviewers meet the requirements to assess AR learning media. This is because AR media must have good quality and

can be accounted for in terms of display quality, software engineering, curriculum, matter presentation, implementation, evaluation, and language. The results of the investigation of the quality of AR learning media products are as follows:

Media Expert

Media experts provide assessments of aspects of display quality, software engineering, and implementation. In addition to evaluating media experts provide input and suggestions to improve the feasibility of AR media. The results of the assessment carried out by media experts are shown in table 1 as follows.

Table 1. Assessment of AR Media by Media Experts

No	Criteria Aspect	Indicator	Maximum score	average score	Ideal percentage (%)	Quality
1	Display Quality Aspects	1,2,3,4,5	25	4.8	96%	VG
2	Software Engineering Aspects	6,7,8	15	4.7	94%	VG
3	Implementation aspects	9,10	10	5	100%	VG
total amount			50	14.5		
Ideal Percentage Total					96.67%	VG

Natural Science Expert

Matter experts provide an assessment of aspects of the curriculum, aspects of matter presentation, aspects of evaluation, aspects of language. The results of research from matter experts are shown in table 2 as follows:

Table 2. AR Media Assessment by Natural Science Expert

No	Criteria Aspect	Indicator	Maximum score	average score	Ideal percentage (%)	quality
1	Curriculum aspects	1,2,	10	5	100%	VG
2	aspects of presenting	3,4,	10	4.5	90%	VG

	natural science material					
3	Evaluation aspect	5,6,7	15	4	80%	G
4	Linguistics	8,9,10	15	4.7	94%	VG
total amount			50	18.2		
Ideal Percentage Total					91%	VG

Assessment of All Reviewers On Each Aspect

Assessment of the overall aspects of AR learning media by 1 media expert, 1 matter expert, 1 peer reviewer, and 1 class teacher. Assessment is carried out from several aspects, namely, aspects of display quality, aspects of software engineering, aspects of implementation, aspects of the curriculum, aspects of matter presentation, aspects of evaluation, and aspects of language. The results of the assessment by all reviewers can be seen in Table 3 as follows:

Table 3. The Quality of Ar Media Is Based On The Assessment of All Reviewers

No	Criteria Aspect	Indicator	Maximum score	average score	Ideal percentage (%)
1	Display Quality Aspects	1,2,3,4,5	13.4	89.3%	VG
2	Software Engineering Aspects	6,7,8	14.4	96%	VG
3	Curriculum aspects	9,10	13.5	90%	VG
4	aspects of presenting natural science material	11,12,13	13.2	88%	VG
5	Implementation aspects	14,15	14	93.3%	VG
6	Evaluation aspect	16,17	12.5	83.3%	VG
7	Linguistics aspect	18,19	13.7	91.3%	VG
total amount			94.7		
Ideal Percentage Total				90.2%	VG

Classroom Teacher

Class teachers assess AR media from aspects of display quality, aspects of software engineering, aspects of the curriculum, aspects of matter presentation, aspects of implementation, aspects of evaluation, aspects of language. The following are the results of the AR media assessment data by the class teacher in table 4.

Table 4. AR Media Assessment by Class Teachers

No	Criteria Aspect	Indicator	Maximum score	average score	Ideal percentage (%)	Criteria Aspect
1	Display Quality Aspects	1,2,3,4,5	25	4.2	84%	VG
2	Software Engineering Aspects	6,7,8	15	4.7	94%	VG
3	Curriculum aspects	9,10	10	4	80%	G
4	aspects of presenting natural science material	11,12,13	15	4	80%	G
5	Implementation aspects	14,15	10	4	80%	G
6	Evaluation aspect	16,17	10	4	80%	G
7	Linguistics aspect	18,19	10	4	80%	G
total amount				28.9		
Ideal Percentage Total					82.57%	VG

Limited Trial

Limited testing is done by looking at student responses in the form of student responses to AR learning media products, students are allowed to assess and provide input. Student assessment includes several aspects, namely aspects of interest in learning, aspects of ease of understanding, aspects of appearance, aspects

of implementation. The results of the overall response to the AR media conducted by 10 students of MI Wahid Hasyim in Yogyakarta are presented in table 5 as follows:

Table 5. Media Quality AR responses of 10 grade V students MI Wahid Hasyim

No	Criteria Aspect	Indicator	Maximum score	average score	Ideal percentage (%)	Criteria Aspect
1	Aspek Minat Belajar	1,2,3	30	2.9	96.67 %	Positive
2	Aspek Kemudahan Pemahaman	4,5	20	1.9	95%	Positive
3	Aspek Tampilan	6,7,8	30	3	100%	Positive
4	Aspek Keterlaksanaan	9,10	20	1.9	95%	Positive
Total			100	9.7		Positive
Total percentage %					97%	Positive

CONCLUDING REMARKS

Based on the research development that has been carried out, several conclusions can be obtained as follows (1) This development has resulted in the learning media of Augmented Reality (AR) natural science subject on the subject matter of Water Recycling for Grade V Students of MI Wahid Hasyim. The development model is procedural, which is a descriptive model and shows the steps that must be followed to produce a product using the 4D model. the steps taken are Define, Design, Develop, and Disseminate, only limited to the Development stage in limited trials. So that the final product obtained by learning media Augmented Reality (AR) is run on Android version 4.1 jelly bean. (2) The media for learning Augmented Reality (AR) based on the overall assessment of reviewers and peer reviewers obtained very good or very decent quality, namely 90.2%. (3) Augmented Reality (AR) based on the response or assessment of teachers and students has a percentage of 82.57% with the teacher's response to the excellent category and the

percentage of 97% in the category is very good and has a positive response by students which is then reinforced by the evaluation results with an average value 82 so that the value of students in science subjects has increased by 35.8% which can be concluded to have a good response. Based on the results of data acquisition shows that the learning media of Augmented Reality (AR) water cycle matter is suitable to be used as a learning resource for students in class V SD / MI.

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