

Development of 3D Math AR Applications as Mathematics Learning Media Augmented Reality Based

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Abstract

This study aims to find out the application of 3D Math AR learning as Augmented Reality-based mathematics media in Class VIII Flat-Side Building Materials at SMPIT Nidaul Hikmah. This type of research is research and development (Research and Development) using the ADDIE development model. This research stage is limited to the implementation stage with limited testing, has not yet reached the testing stage with a broad scale of the Covid-19. The data collection technique used was a questionnaire that was distributed to 1 Mathematics Subject teacher and 10 Class VIII students at SMPIT Nidaul Hikmah. Based on a limited test conducted using a Likert measurement scale, the results of media expert validation with an average of 4.5 are in the very good category, while material experts with an average of 4 are in a good category, so that the cumulative results of the assessment by media experts and material experts an average of 4.25. Practical of learning media assessed by and teachers got an average result of 4,325 in the Very Good category. After being declared valid and practical, it can be concluded that the 3D Math AR application is feasible to use.

Keywords: development, augmented reality, 3D Math AR

INTRODUCTION

The results of the Kominfo survey in 2017 show that more than half of Indonesians already have smartphones, namely 66.31% of them based on the profession of students / students at 70.98% and based on the level of education 59.89% of users are junior high school students (KOMINFO, 2017). However, the majority of the utilization of existing platforms is only used for entertainment activities and spending time. This shows that the utilization of technology, especially smartphones, is still very little in educational activities. Meanwhile, the



utilization of information technology should be able to provide great benefits if used properly and wisely, one of which is by utilizing technology in the field of education.

The rapid development of science and technology requires educators to always make updates in the utilization of technological results, especially in the field of education. One of the utilizations of smartphone technology in the field of education is used as learning media. The use of Android-based learning media is one of the applications of 21st century learning styles (Calimag et al., 2014). The use of this type of learning media has the potential to help improve students' academic performance in the form of learning outcomes in the cognitive domain (Chao & Chang, 2018) and students' learning motivation (Hess, 2014). (Meister, 2011; Squire, 2009) mentioned that the implementation of learning using smartphones can have a positive impact on cognitive, metacognitive, affective, and socio-cultural dimensions. Smartphones have the power to transform the learning experience. This type of learning media allows students to learn not limited by time and place with interesting applications (Yektyastuti & Ikhsan, 2016)

According to the math teacher at SMPIT Nidaul Hikmah, one of the 8th grade materials that students find difficult is the material on flat-sided spaces. Students have difficulty visualizing flat-sided spaces and calculating the surface area and volume of flat-sided spaces. Abstract flat-sided space material and the perception of students towards mathematics, more formulas are given without an explanation of the origin of the formula and its usefulness in everyday life, making one of the factors that hinder students in understanding flat-sided space material (Pujakusuma, 2018). In order to assist students in visualizing objects, android-based learning media will be used in learning flat-sided space, as revealed by (Rahman et al., 2017) that learning media is a tool or intermediary that is useful to facilitate the teaching and learning process, in order to streamline communication between teachers and students. The thing that must be changed is how to change the negative view or mindset about math lessons and make smartphones and tablets can be a tool or learning media that is easy to understand and interesting as a learning medium.

Current technology trends can embrace students with visual, auditory, and kinesthetic learning styles simultaneously in one medium. One of these technologies is Extended Reality (XR) which includes Augmented Reality (AR), Virtual Reality (VR), and Mixed Raelity (MR) which is able to provide a more real learning experience so that its functions and benefits are felt in learning.

The development of learning media using Augmented Reality-based android applications can be used as an alternative in solving these problems. Augmented Reality is a combination of real and virtual objects in the actual environment, with the time being and there is integration between objects in 3D form, namely virtual objects integrated in cyberspace (Najib & Yuniarti, 2018). The incorporation of real and virtual objects in 3D using certain program devices and having reliable integrity requires an effective observation. Augmented Reality technology is a visual technology that combines virtual world objects into real world displays in real time. By utilizing Augmented Reality technology and android smartphones, objects can be visualized concretely through three-dimensional virtual modeling that is similar to the original object right above the image on the paper (Sugiarto, 2021). Augmented Reality-based learning media also has advantages, which can be accessed using android devices such as smartphones and tablets. Through Augmented Reality, teachers can create learning media fun, interactive, and easy used (Mustaqim & Kurnaiwan, 2017). Utilization of educational media using Augmented Reality can stimulate the mindset of students in think critically about a problem and events that occur in daily life (Mustaqim, 2016). The combination of Augmented Reality technology with learning mathematics flat-sided space building material creates a new type of application that is used to increase the effectiveness and attractiveness of teaching and learning for students in real life. The point is that we can bring three-dimensional virtual objects into the real world through the smartphone camera, so that students can directly interact with the flat-sided space building object. With the development of Augmented Reality-based learning media in learning mathematics flat-sided space material is expected to make it easier for teachers to no longer need to make props, all students will have their own props in the form of virtual space that can be taken anywhere, students will be more interested in props in the form of Augmented Reality technology. Learning media using android applications based on Augmented Reality flat-sided space material can also be used as a medium for independent learning of students at home. Therefore, a research was conducted entitled: "Development of 3d Math AR Applications as Mathematics Learning Media Augmented Reality Based".

METHODS

This type of research is development research. Research and development is a research method with the aim of producing certain products and testing the effectiveness of these products. Based on this theory, the research and development method will produce a new product or improve existing products (Sugiyono, 2010).

The product produced from this research is learning media in the form of augmented reality-based android applications on flat-sided space building material. The research and development method phase used in this research is ADDIE (Analysis, Design, Development, Implementation and Evaluation).

This research and development procedure uses the ADDIE development model. The ADDIE model was developed as an innovative learning model because it provides a systematic, effective, and efficient learning process packaged in learning steps. The ADDIE model was developed by Dick and Carry in 1996 to design learning systems (Mulyatiningsih, 2012). This model can be used for various forms of product development in learning activities such as models, learning strategies, learning methods, media and teaching materials (Mulyatiningsih, 2016). This model uses 5 stages of development namely Analysis, Design, Development, Implementation and Evaluation.

Table 1. The Stages of ADDIE Model

| Stage | Description |
|-----------------------|--|
| <i>Analysis</i> | The analysis stage is an initial study conducted to identify the mathematics learning process that applies to schools as a consideration in developing Augmented reality-based learning media. The school subject to this stage is SMPIT Nidaul Hikmah. The analysis activities carried out are by observation and interviews. Interviews were conducted with 8th grade math teachers at SMPIT Nidaul Hikmah. Interviews are conducted to obtain information about direct problems in learning mathematics which are used as a reference in the development of learning media. |
| <i>Design</i> | At this stage, four stages of media production will be carried out, namely: (a) designing material, (b) designing AR camera, (c) creating menu structure and (d) creating interface design. |
| <i>Development</i> | Development is one of the stages in the ADDIE development model which aims to obtain valid media. In this development stage includes the product manufacturing stage. The development stage in this study is the stage of making learning products, which is divided into two stages, namely making learning modules and 3D Math AR android applications. In making learning modules using Microsoft Word computer software and 3D Math AR android applications made using Unity 3D software. |
| <i>Implementation</i> | At this stage is the product testing stage, whether the product is suitable for use or not. At this stage, product validation tests will also be carried out, validation is carried out by involving material experts and media experts. This is intended to find out whether the product developed is ready and suitable for use or not. In addition to being validated by one media expert and one material expert, and by testing on teachers and students. |
| <i>Evaluation</i> | Evaluation is carried out in two forms, namely formative and summative evaluation. Formative evaluation is carried out at the end of each lesson, while summative evaluation is carried out after the activity has ended as a whole. Summative evaluation measures the final competence of the subject or learning objectives to be achieved. Evaluation results are used to provide feedback to the users of the model/method. Revisions are made according to the evaluation results or needs that cannot be met by the new model/method. |

RESULTS AND DISCUSSION

Researchers innovate to develop products from ordinary 2D image media into 3D Augmented reality applications, in order to support learning, especially in mathematics subjects, especially in geometry material, given the importance of image media in mathematics lessons, especially in geometry material. Therefore, researchers develop Augmented reality applications on flat-sided 3D space shapes that are mobile-based portable or can be used anywhere. This application is a combination of print media and computer technology that will be used as an application on smartphones, especially android. This application requires a camera on a smartphone as an input medium to read markers (special markers), where the marker will display three-dimensional models and animations on the smartphone screen.

In make an application, there are stages that must go through (Legya, 2015). Development of 3D Math AR Application as Augmented Reality-Based Mathematics Learning Media on Class VIII Flat-Sided Spatial Buildings Material at SMPIT Nidaul Hikmah in accordance with the steps of the ADDIE Research and Development research procedure which consists of the Analysis, Design, Development, Implementation, and Evaluation stages.

Based on direct observations and interviews conducted with the teacher teaching mathematics class VIII SMPIT Nidaul Hikmah, namely Mrs. Erna Ayu Rohkhayani, S.Pd. The results of the interviews can be seen in table 2.

Table 2. Results of Interview with Teacher

| <i>Result of Interview</i> |
|--|
| 1. The material of building space is considered to be one of the difficult materials, because in addition to calculating students are required to be able to understand the concept of building space. |
| 2. Not a few students have difficulty in imagining illustrations of flat-sided spaces and understanding how to calculate the surface area and volume of flat-sided spaces. |
| 3. In the process of learning mathematics, the teacher conveys the material of flat-sided spaces using the lecture method and drilling practice questions which are still less effective because students tend to be ignorant and passive. |
| 4. Limited learning resources in the form of student handbooks in learning flat-sided space building material which is considered inadequate in terms of visualization of 3D objects. |
| 5. The limited time of teachers in teaching which is only 30 minutes for one meeting and only once a week, while the students' memory period is very short. |
| 6. Almost all students already use smartphones and there is no prohibition to bring or use smartphones in the classroom as long as it does not interfere with learning. |
| 7. The use of smartphones in the learning process has not been optimized. |

From the results of the data collection above, augmented reality-based learning media using android is made that can increase student learning motivation so that it can be used for independent learning at home. Further development is carried out starting from the design by designing the material, designing the AR camera, designing the menu structure, and designing the interface.



Figure 1. Designing Media Unity 3D Interface

After that, the development stage is carried out. This stage is the stage for producing programs and teaching materials in the form of learning media with rectangular shape material. The development of this learning media consists of several stages which include the preparation of learning media designs followed by the making of learning media programming, and the completion stage by checking errors in the learning media.

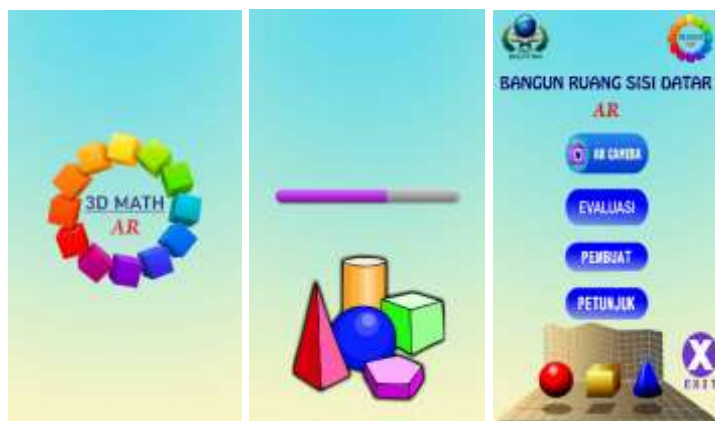


Figure 2. Learning Media Intro Display



Figure 3. AR Camera display

The learning media formed are then implemented in learning activities to find out how the learning media influences the increase in student interest, understanding, and skills. At the end of the learning media there is a quiz to measure students' understanding of the flat sided space.

After the learning media is formed, then evaluation is carried out. Based on the validation results of media experts and material experts, it can be concluded that learning media based on *Augmented Reality* is said to be "valid" with the results of the media expert's assessment getting a score of 68 or an average of 4.5. Material experts get a score of 73 with an average of 4. So that cumulatively the results of the assessment by media experts and material experts get an average of 4.25 in the "Very Good" category. From these data it can be concluded that the developed *Augmented Reality*-based learning media is categorized as valid, so that the developed learning media can be tested.

Based on a limited trial, the mathematics teacher at SMPIT Nidaul Hikmah Randuacir Salatiga received a score of 80 with an average of 4.2 and these 10 students got an overall result of 713 or an average of 4.45. So that cumulatively the results of the assessment by teachers and students got an average of 4.325 in the "Very Good" category. So that the developed *Augmented Reality*- based learning media using Android is stated to be practical to use.

This research show that This study shows that the Development of 3d Math AR Applications as Mathematics Learning Media *Augmented Reality* Based is appropriate for learning activity and beneficial to improve students' learning motivation. This is align with a lot of research examines the benefits of using mathematics learning media, namely on students' learning interests (Dewi, 2019; Nurfadhillah et al., 2021; Puspitarini, 2019; Wulandari, 2020), student independence (Fifko, 2017; Kusumawati & Lestari, 2022; Nadhifah et al., 2019), learning outcomes (Firdaus, 2017; Prastica et al., 2021; Rahayu et al., 2021), learning

motivation students (Novianti et al., 2022; Pertiwi et al., 2019; Wulanningtyas et al., 2021), and the others.

CONCLUSION

In this development research, a product was produced, namely the 3D Math AR application as an *augmented reality-based learning medium* using Android on flat sided space building materials for class VIII SMPIT Nidaul Hikmah Randuacir Salatiga. This learning media was developed with the help of *Unity 3D, Blender, and Vuforia software*. This research uses the ADDIE development model which consists of five research steps, namely *Analysis, Design, Development, Implementation, and Evaluation*. The results of the assessment in this study stated that the learning media developed were "valid" for use in learning mathematics on flat sided geometric material. Based on the results of the media expert's assessment, a score of 68 or an average of 4.5 was obtained. Material experts get a score of 73 with an average of 4. So that cumulatively the results of the assessment by media experts and material experts get an average of 4.25 in the "Very Good" category. From these data it can be concluded that the developed Augmented Reality-based learning media is categorized as valid, so that the developed learning media can be tested. Furthermore, the product was tested on 1 math teacher and 10 students. Based on a limited trial, the mathematics teacher at SMPIT Nidaul Hikmah Randuacir Salatiga received a score of 80 with an average of 4.2 and these 10 students got an overall result of 713 or an average of 4.45. So that cumulatively the results of the assessment by teachers and students got an average of 4.325 in the "Very Good" category. So that the developed Augmented Reality-based learning media using Android is stated to be practical to use.

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