

Development of Android-Based Augmented Reality Learning Media through Project-Based Learning on Flat Side Space Building Materials to Improve Students' Spatial Mathematics Skills at SMPN3 Medan

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| Article Info | ABSTRACT |
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| <p>Keywords: Development, Android, Augmented Reality, learning Outcomes</p> | <p>Augmented Reality (AR) is a technology that combines the real and virtual worlds by displaying 3D objects through the device's camera, so that the objects look real. This research aims to develop and test the feasibility of an Augmented Reality-based module that can improve students' spatial abilities. Augmented Reality is a technology that can combine the real and virtual worlds by displaying three-dimensional (3D) objects on the device's camera media so that on the device screen you can see 3D objects that appear to exist in the real world. Alat yang digunakan termasuk observation sheets, expert validation sheets, interview guidelines, questionnaires for teachers and students to respond, learning outcome tests, and pre- and post-tests of student spatial abilities. Qualitative and quantitative data are the two types of data that are analyzed. The data validation data analysis, practicality data analysis, dan effectiveness data analysis. The research found that the material expert score was 91.53% and the design expert score was 90.53%, both in the very valid category. The module was also considered practical, as demonstrated by the teacher response questionnaire's 80.00% score in the practical category, and the questionnaire's score in the small group trial was 84.26% in the practical category. Based on the research results, it can be concluded that the Augmented Reality-based module for flat-sided building material that has been developed is suitable for use as a learning teaching material. The results of the N-Gain calculation showed that 11 students saw a moderate increase in spatial ability, and 13 students saw a high increase in spatial ability. The goal of this study was to create learning media for mathematics in junior high school based on android-based augmented reality. The research development (R&D) methodology was used, and the development model used was the ADDIE model for analysis, design, development, implementation, and evaluation. In this study, the product has been tested for validation by media experts, material experts, and linguists, as well as students on a small scale. The result 96%, 94%, 88%, dan 91% validation by students, learning media with android-based augmented reality is a very viable category. Therefore, learning media with android-based augmented reality deserves to be used as a medium of learning mathematics for junior high school students.</p> |
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INTRODUCTION

The development of information technology is currently increasing day by day, in this increasingly modern era, sophisticated technology is also being created according to human needs. Technological developments also have a big influence on the field of education. Currently, there are many media or learning aids that use ICT, one of which is mathematics subjects. We all know that mathematics is one of the

subjects that children don't like. Teachers are aware of this obstacle, but there are still many teachers who do not make every effort to reduce or even turn it into learning that attracts students' interest.

Bruner (in Suharso, 2012) emphasizes that children learn mathematical concepts through three stages, namely enactive, iconic, and symbolic. The enactive stage is a learning stage where students are given the opportunity to manipulate objects or concrete objects directly. The iconic stage is a learning stage where students manipulate concrete objects into images. The symbolic stage is the stage of learning to combine the world where students manipulate the images in the previous stage into mathematical symbols. This is in accordance with the constructivist perspective, a perspective in teaching and learning where students construct their meaning from their experiences and interactions with others. Meanwhile, according to Piaget (Hudoyo in Utami, 2016), the level of thinking of elementary school age children is still concrete operational, meaning that to understand a concept, children still need to be given something related to real objects that can be accepted or activities related to real events in their minds.

Learning Media

Arsyad (2013: 3) explains that the word "media" comes from the Latin "medius," which means "intermediary, introduction, or middle." In Arabic, media also means an intermediary who conveys a message from the sender to the receiver. In the context of education, media is a photographic, graphic, or digital tool used to process, organize, and display visual or verbal information. Learning media is a tool used in the teaching and learning process, including as a tool for teachers to teach and convey messages from learning resources to students (Laman, C., 2005: 7)

Augmented Reality (AR)

Augmented Reality (AR) is a technology that creates 2D and 3D virtual objects that are applied in real conditions, then these virtual objects are projected in real time and become closer to the real environment of the system. Virtual Reality is different from Augmented Reality which is a real environment (Ahmad Burhanudin, 2017: 32). Augmented reality is a way to combine virtual objects or objects into the user's real environment and then project them in real time (Lisiwanti, 2015: 102). Utilizing the help of augmented reality technology, the real environment around us will be able to interact in digital form (virtual). Information about objects and the environment around us can be added to the augmented reality system, where the information is then displayed on the real world layer in real time as if the information were real. Augmented reality is a branch of technology that is not very old, but has developed very quickly. The development of augmented reality in the mobile phone industry also has the fastest development. Augmented reality not only adds or complements reality but also allows users to interact in real time with the system (Litanianda & Setyawan, 2017). One of the new developments in learning media is learning media using Augmented Reality technology.

According to Sari (2013), one of the causes of low student learning outcomes is that the learning method used by teachers only uses the lecture method, resulting in students not being motivated to learn. Related to this, teachers need to improve effective and efficient learning so that students can more easily understand mathematics lessons, so that student learning outcomes will be more optimal. The scope of mathematics learning in schools, at the junior high school level, includes algebraic numbers, geometry and measurement as well as statistics and probability (Sari, 2017). The scope of geometry is easier for students to understand. This is because the ideas of geometry are introduced to students before they go to school. Buchori (2017) said that basically geometry has a greater opportunity for students to understand it than other branches of mathematics.

Low student achievement is also indicated because students are less motivated when learning mathematics, especially flat-sided geometric material. It is possible that students are unable to imagine shapes correctly and learning in class is too monotonous. In addition, most teachers also often use lecture methods and media in the form of PowerPoint, so students tend to feel bored and not pay attention when the teacher explains the lesson material. To create a quality learning process, teachers often encounter difficulties. These difficulties can be seen in the implementation of mathematics learning in schools which still shows shortcomings and limitations. One of them is providing a concrete picture of the material presented, so that this has a direct impact on the low quality of learning outcomes achieved by students. According to the results of observations made by researchers at SMP Negeri 3 Medan, it shows that the mathematics learning process is less active and less interesting, this is due to the lack of media that supports the learning process. Another obstacle is caused by the lack of school facilities, such as the unavailability of LCD projectors in each class which supports teachers to make the delivery of material easier.

RESEARCH METHOD

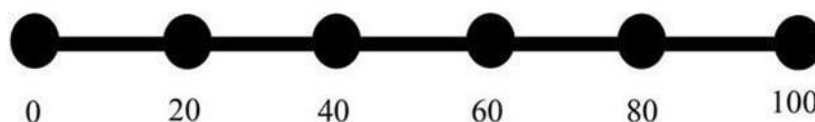
This research applies research and development (R&D) methods. According to Perdana (2020), this method is used to develop and test products that will be used in the context of education. The research process includes the following steps: 1) data collection through analysis of needs from students and educators, as well as material specifications; 2) product design; 3) product manufacturing and development; and 4) product validation by three expert validators: a media expert from the University of Muhammadiyah North Sumatra, a material expert from SMPN3 Medan, and a linguist from the University of Muhammadiyah North Sumatra. The data collection method uses verified questionnaires to test the feasibility of the product. This study evaluates various aspects of the product such as materials, software, design, language, and media display using the Likert scale. The responses from experts and students were analyzed by giving a score of 4 for Strongly Agree (SS), 3 for Agree (S), 2 for Disagree (KS), and 1 for Disagree (TS), without using the category of "Strongly Disagree" (Sugiyono, 2016). The focus of this research is how to create android-based AR learning media and use a percentage descriptive system to analyze data. To analyze the data from the questionnaire, the following steps are taken: 1. Quantifying the results of the questionnaire according to the indicators to be measured by providing a score according to the predetermined weight; 2. Creating data tabulation; and 3. Use the following formula to determine the eligibility percentage of each element:

$$X_i = \frac{\sum S}{S_{Max}} \times 100\%$$

The percentages obtained are then converted into tables to make reading the table results easier. To determine the quantitative criteria is carried out by :

- Determine the ideal score percentage (maximum score) = 100%
- Determining the lowest score (minimum score) = 0%
- Specify the range = 100 – 0 = 100
- Determining the desired interval = 5 (Very Feasible, Feasible, Moderately Feasible, Less Feasible, and Not Feasible).
- Determining the width of the interval = 100 : 5 = 20

Based on the previous calculations , the percentage range can be set as follows:



The research is said to be successful if the results of the questionnaire are obtained in the range of 61% - 80% with the feasible category and 81% - 100% with the very feasible category.

Tabel 1. Percentage Range

| No | Rentang Persentase | Kategori Kelayakan |
|----|--------------------|--------------------|
| 1 | 81%-100% | SL (Sangat Layak) |
| 2 | 61%-80% | L (Layak) |
| 3 | 41%-60% | CL (Cukup Layak) |
| 4 | 21%-40% | KL (Kurang Layak) |
| 5 | <21% | SK (Sangat Kurang) |

The researcher observed and found the following results from online observations that are relevant to this study: 1. The use of Augmented Reality (AR) as a learning medium to build flat-sided spaces is still relatively rare. 2. The majority of students in Junior High School have Android-based smartphones. As the pandemic continues, teachers are adopting the use of Zoom, video, and even Google Classroom to provide material explanations.

RESULTS AND DISCUSSION

From this research, an Augmented Reality application was produced as an innovative learning medium and it is hoped that it can help in the mathematics learning process in class easily and funly. The contents of the Augmented Reality created are as follows:

Analysis Stage of Augmented Reality Learning Media Development

This stage is the basis for creating a product design which is done by providing a needs questionnaire to students and teachers. In this stage, the researcher selects material regarding flat-sided and curved-sided spatial shapes which will be designed in learning media based on basic competency references.

According to online observations related to this research, researchers analyzed and obtained the following results:

1. The application of AR is still rarely used as a learning medium for building flat-sided spaces.
2. Most junior high school level students have Android-based smartphones.
3. Because we are still in a pandemic situation, the teacher explains the material using video, zoom, and even just provides material on Google Classroom.

And also perform hardware and software analysis. In this research, a hardware system is definitely needed to design the development of this application. The author uses a laptop with AMD Ryzen 3 4300U quad-core (4 thread) processor specifications with a maximum speed of 2.7 GHz Turbo 3.7 GHz. Windows 10 Home x64 operating system and 8GB RAM. The software used is Unity 2018.2.18f1 as the main application for creating Augmented Reality applications, Vuforia which is imported into Unity to be used as image

recognition. Java JDK and Android Studio as supporting software are very important in the process of creating this application as well as Microsoft Word 2019 which is used to create interactive books.

Augmented Reality Media Design Stage

This stage aims to make it easier for writers to develop applications that will be made to suit their needs.

1) Main Menu

The main menu is the center of the application display when running, this menu consists of several buttons, namely:

- a. AR Menu
- b. Material
- c. Quiz Games
- d. Exit/Exit

2) AR Menu

The augmented reality menu is a camera menu that functions to display 3-dimensional objects if directed at the marker available in the interactive book.

3) Space Building Materials Menu

The researchers named the space building materials menu in this application "Materials". This menu is a menu that provides information about all spatial structures. An example of this menu display can be seen in the picture.

4) Quiz View

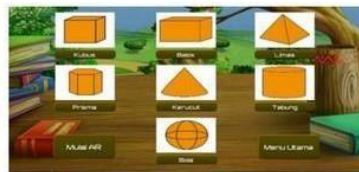
This menu contains a question panel, answers, score, and two buttons that function for questions next and return to the main menu. It can be seen in the picture.

Development Stage

The development stage is the real stage after the design has been completed. The design that has been designed is then implemented in making the application with several preparations such as downloading the software to be used, preparing supporting files in making the application, and coding. The results at this stage are presented in figure 4-12.



Gambar 4. Menu Utama



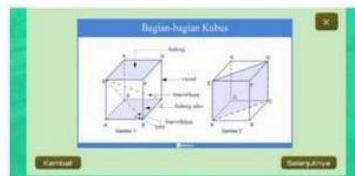
Gambar 5. Menu Materi



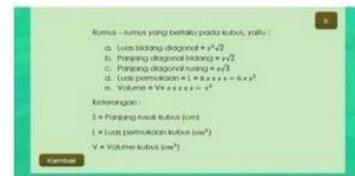
Gambar 6. Menu Kuis



Gambar 7. Menu AR



Gambar 8. Isi Menu Materi



Gambar 9. Isi Menu Materi



Gambar 10. Cover



Gambar 11. Materi Bangun Ruang



Gambar 12. Latihan Soal

Figures 4 to 9 are the displays in the Android-based Augmented Reality spatial building application. Figures 10 to 12 are interactive book displays in which there are markers that can be accessed in the application to display spatial images in 3 dimensions.

The next step is that the Augmented Reality learning media is validated by experts and students. In validating the learning media, it was given to experts consisting of 1 lecturer and 2 teachers and 10 students. Validation tests by experts are carried out to determine the feasibility level of a product that has been developed. Validation tests were carried out by material experts, media experts and language experts.

Table 2. Validation Test Results

| No | Validator | Nilai Persentase | Kategori |
|----|---------------|------------------|--------------|
| 1. | Ahli Media | 95% | Sangat Layak |
| 2. | Ahli Materi | 93,75% | Sangat Layak |
| 3. | Ahli Bahasa | 87,5% | Sangat Layak |
| 4. | Peserta Didik | 90,19% | Sangat Layak |

Implementation Stage

At this stage, the product is tested on students on a small scale, namely 10 people and given a questionnaire to fill out the validation sheet. Due to the current pandemic conditions, the implementation stage is only being tested on a small scale.

Evaluation Stage

The final stage is carrying out an evaluation, only formative evaluation is carried out because this type of evaluation is related to the development research stage to improve the development product produced. Evaluation is obtained from suggestions and input from students and experts during validation.

The learning media for mathematics subjects in the spatial material developed are interactive books and Android-based augmented reality applications. The media is developed in the form of an application that can be run on an Android smartphone, so it is easy to use and practical. Researchers are of the opinion that as time goes by, almost all groups use electronic media as a necessity and also as a means of daily communication, including students who already use electronic media such as laptops/smartphones. The majority of students spend more time holding electronic devices playing games or opening social media than studying. Apart from that, because currently the learning system is carried out online and students automatically learn through their own electronic devices, researchers use electronic media to develop electronic media or smartphones to develop Android-based learning media applications and interactive books. With the aim that students can study independently at home using the application that researchers have developed. The product being developed will be carried out in accordance with procedures that have been developed by Robber Maribe Brach, the research model is the ADDIE model with five stages, namely analysis (needs analysis and specification analysis), design (product design), development (product development), implementation (product implementation with small group trials), and evaluation (product evaluation). The first stage of this development is to carry out an analysis which consists of two stages, namely requirements analysis and specification analysis. Needs analysis, researchers divide it into two, namely the needs of students and the needs of teachers for learning media. Next, the second stage is to design an application learning media product that contains AR menus, materials and quiz games. Then there are improvements in terms of design, there are several displays and menu options, there is sound when the application is used, and there are 3D images when the camera is scanned into an interactive book so that it gives a real impression for students in learning spatial building material. The third stage is the development of interactive applications and books built using the Unity application. At this stage, design planning is needed which starts with searching for images for the background so that it looks attractive to students. Next, design the application menu which has 3 menus, namely, AR menu, materials and quiz games. Then, after the application and interactive book have been developed according to the plan, a validation process is carried out to determine the feasibility of the product being developed according to several experts, namely media experts, material experts and language experts.

Based on the assessment of media experts, the overall percentage was 95% and was included in the very feasible category. The results of the material expert assessment obtained an average percentage of 93.28% which can be declared very feasible. And the assessment from language experts obtained a score of 87.5%, so it can be categorized as very worthy. The fourth stage is the implementation stage, this stage is carried out by testing the product as a learning medium on a small scale for students. Based on the overall results, this product was declared very feasible because it received a percentage of 90.19%. Student responses from the questionnaire stated that this learning media was suitable for students but also provided suggestions for making the product better. Then revise the results of product trials based on suggestions from experts and students. The suggestion is to add a question discussion menu in applications and interactive books so that students have examples for working on questions contained in applications and interactive books.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the problems faced by many class VIII students at SMP Negeri 3 Medan are difficulties in understanding flat-sided building materials and the minimal use of interesting learning media in class. So students need integrated learning media such

as interactive books and Android-based Augmented Reality applications so that students are interested in learning and can easily understand material that can be studied independently. Creating learning media with Android-based augmented reality can be done using the ADDIE development model, using several software including Unity, Vuforia, Adobe Illustrator, Canva, and others. Android-based Augmented Reality so that students are interested in learning and easily understand material that can be studied independently. Creating learning media with Android-based augmented reality can be done using the ADDIE development model, using several software including Unity, Vuforia, Adobe Illustrator, Canva, and others. The assessment results from media experts, material experts and language experts show that interactive books and AR applications are in the very feasible category so it can be concluded that interactive books and AR applications are suitable for use by class VIII students in mathematics subjects.

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