DEVELOPMENT OF AUGMENTED REALITY-BASED LEARNING MEDIA ON INSTAGRAM FILTER TO IMPROVE STUDENTS' MATHEMATICAL PROBLEM SOLVING ABILITY

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Abstract

This research is motivated by the low ability of students' mathematical problem-solving. One reason is the need for instructional media, so students feel less interested in learning mathematics. In teaching, media technology can be used, one of which is by using augmented reality which has the advantage of being able to project objects. Therefore, learning media based on augmented reality is needed to improve mathematical problem-solving abilities with the help of Instagram social media filters. Instagram was chosen because it is easy to use, and many users already use it. This development research adopts the ADDIE development model, which has five stages, namely Analysis, Design, Development, Implementation, and Evaluation. This research was conducted at SMP Negeri 1 Waringinkurung, with 24 students as test subjects for class VIII students. The results of due diligence based on three material experts and three media experts obtained a percentage of 89.41% and 86.33%, respectively, both of which were included in the very decent category. The response of students and teachers in this research was excellent, with a teacher percentage of 89.95% and a teacher percentage of 89.09%, both of which fall into the convenience category. Then, students' mathematical problem-solving abilities increased to the moderate category after learning with the developed learning media. The N-Gain Score result of 66.23% is included in the medium criteria. Then, based on the one-way paired t-test, the results of the posttest increase were t-count = 15.25 and t-table = 1.71, which means t-count > t-table. This shows that students experienced a rise in the average posttest score compared to the average pretest score. Based on this, the developed learning media meets the criteria of being feasible, practical, and effective to be applied in learning mathematics.

Keywords: Learning Media, Augmented Reality, Mathematical Problem Solving Ability.

INTRODUCTION

Mathematics is taught at every level of learning; this is because mathematics is the queen of science (Alifia & Pradipta, 2021). In the process, mathematics has a different view of each student; based on this, it can be due to students' lack of interest in mathematics.

Every student's view of mathematics is different from one another. For students who have a penchant for mathematics will be motivated and like learning and working on math problems. However, it is possible for students who do not like mathematics to decrease motivation or not like learning and working on math problems. The views held by students can influence their mathematical abilities.

Based on the presentation of the National Council of Teachers of Mathematics (2000), there are five basic mathematical abilities of students, including representation, reasoning,

connection, communication, and problem-solving skills. All these abilities are essential for every student, including problem-solving abilities.

An essential thing considered necessary for students when learning mathematics is problem-solving. This role is considered vital because it can build student confidence and increase students' abilities in making decisions that will be faced in everyday life (La'ia & Harefa, 2021). So, it is an essential provision for students to face the future.

The math ability of students in Indonesia can be much higher. The Program for International Student Assessment (PISA) survey in 2018 demonstrated this low possibility. To measure student ability when solving everyday problems by applying mathematics knowledge and skills. In the study of 79 participating countries, Indonesia was ranked 73 (Rambe & Afri, 2020). One of the main topics in PISA is geometry. One of the main themes of the PISA questions is geometry, a problem that Indonesian students struggle to solve. (Nina et al., 2022).

The material for building flat sides is closely related to geometry. This material consists of pyramids, prisms, beams and cubes. It includes part of geometry. Where visualization is needed with the aim that students are able to understand the concept of flat-sided shapes (Meilinda et al., 2019).

There is an influence arising from the concept of flat-sided shapes in everyday life. Students need to understand it. However, this concept must still be explained for students to understand (Mutia, 2017). So, it affects students' abilities when solving mathematical problems.

Accordingly, it is essential to have learning the media when teaching in class, especially learning media that can visualize the concept of flat-sided spatial shapes. Because visualization it helps students in describing an object. As well as to help students to solve mathematical problems. Technology can be a solution to making learning media.

Education has developed hand in hand with technology. Technology that is present today is a form of product from schooling that takes place in human life. With increasingly sophisticated technology, many digital platforms, commonly known as social media, have emerged. Of the various types of social media, Instagram is the one that has survived to this day. Based on survey data from We Were Social in 2022, Instagram has 99.15 million users in Indonesia. This places Instagram in the top second after Facebook as social media with the

most users. Also, above TikTok and Twitter (Endah et al., 2022). However, Instagram is easier to operate and supported with attractive features. One of the features of Instagram is the Instagram filter. Instagram filters can change the image displayed by the camera. This is an example of using augmented reality.

Augmented reality or commonly known as AR, is the ability to combine multimedia with the natural world using electronic devices (Adrian et al., 2020). With augmented reality, users can see 3D and 2D virtual objects projected onto the natural world in real-time.

Many creations are made through the application of augmented reality on Instagram filters. However, Instagram filters are rarely used as learning media. It can be used as a variation in learning, especially in mathematics, in the hope that the student's ability to solve math can be improved and better.

Following this description, the author wants to examine class VIII students of SMP Negeri 1 Waringin Kurung. SMP Negeri 1 Waringin Kurung is a school that is open to the use of technology in learning. Teachers in schools realize that technology can be a positive way of learning for students. However, the learning materials that teachers are about to apply are always looking for suitable materials to improve students' math problem solving ability. Because it focuses on the results of interviews and observations with the school math teacher and the associate superintendent in the academic field, it is necessary to increase students' abilities in solving mathematical problems in students of SMP Negeri 1 Waringin Kurung.

As described above, the authors wanted to develop augmented reality learning materials on Instagram filters to improve students' math problem solving. Next, consider the effectiveness, practicality, and feasibility.

METHODS

The researchers took the test subjects (users) were class VIII students even during the semester at SMP Negeri 1 Waringin Kurung. In selecting students who would become test subjects, a purposive sampling technique was used, which was determined according to specific considerations and criteria for the sample criteria for this research, namely class VIII students who had Instagram accounts. Sampling was adjusted to the concerns of the school mathematics teacher with a total of 24 students. Apart from students, there were also media

and material experts and a class VIII mathematics teacher at SMP Negeri 1 Waringin Kurung as subjects in this research.

Research and development is a method for obtaining results in the form of certain products and knowing their effectiveness (Sugiyono, 2018). Aims to create innovative products so that students' abilities in solving mathematical problems can increase in learning data-side geometrical materials in mathematics learning through augmented reality-based media on Instagram filters.

Researchers conduct research and development in education. In general, many models are used, including ADDIE development model, as reference in this research. This model includes analysis, design, development, implementation and evaluation.

To obtain information or research data on the product being developed. Researchers make instruments that are adapted to the previous grid. The instrument consists of a media validity or feasibility questionnaire, a response questionnaire, and an instrument test. Media validity or feasibility questionnaire to determine the value experts give to the media being developed. There are two experts, including media experts and material experts. The purpose of having a response questionnaire is to see the views or responses of students and teachers to the teaching and learning media that are made. At the same time, test instruments include a pretest and posttest, which are adjusted to indicators of solving mathematical problems to determine students' increased ability to solve mathematical problems.

As for the data analysis technique used by researchers in the form of data analysis on the practicality and effectiveness of augmented reality-based teaching and learning media on Instagram filters to improve students' ability to solve math problems validity analysis is used to test how the validity of teaching and learning media is developed. The validator validates every aspect of learning media. Then the practicality analysis is used to see how practical the researcher applies teaching and learning media. Furthermore, analysis of the practicality of the teaching and learning media that the researchers developed with the policy data from the questionnaire responses of teachers and students. The usefulness of effectiveness is analysed

to see how the point of learning media is made. The results of student tests were used both before and after using media developed for effectiveness analysis in this research.

RESULTS AND DISCUSSION

There are five stages in the development of augmented reality-based learning media: analysis, design, development, implementation and evaluation. The sub-material in this development process is in the form of cubes and blocks in flat-sided spaces. The material was taught to Grade VIII students of SMP Negeri 1 Waringinkurung.

Researchers initially interviewed the teacher of mathematics at SMP Negeri 1 Waringinkurung. This is to see information about the needs of schools in learning mathematics, the curriculum taught and the characteristics of students in learning, especially when learning mathematics. Based on interviews with school teachers, information was obtained that schools are open to using technology in education. However, there still needs to be more use of technology in learning. Apart from that, based on the opinion of the vice principal in the field of the curriculum as well as the opinion of the teacher of mathematics, he explained that in terms of students' abilities in solving mathematical problems, they still needed to be improved. The curriculum taught uses the 2013 curriculum. The information obtained regarding the characteristics of students who have entered their teens. At this age, students are already active in using devices, especially on social media. So with the use of technology-assisted by social media plus the advantages of augmented reality, it is hoped that it can improve students' abilities in solving mathematical problems.

The next stage is design. Mathematics learning media began to be designed by researchers. The researcher chooses to design teaching and learning materials based on augmented reality because with the existence of this medium, it is expected that with its advantages, it can provide real images of the material, especially on flat shapes. The researcher then chose to use teaching and learning media by utilizing Instagram social media because students are used to using it. The designed learning media will be run as an Instagram filter.

At the design stage, the software is prepared that will be used in making learning media products. The Spark AR software is used to create filters that will run on Instagram social media. Spark AR software is used because this software is a meta product used to develop

Instagram filters. The choice of Instagram social media as an application that runs the product is due to its ease of use. In addition, students are used to using Instagram. Then, the product used supporting software such as Blender and meta spark player. Websites like canva and meta spark studio are also used.

Researchers at the development stage create augmented reality-based learning materials using Spark AR. However, researchers first prepare 3D objects using Blender and then create material with graphic designs using Canva. During the preparation, the researchers used Spark Ar to program the filter, which is created by identifying the image before the 3D object appears. The Instagram filter is divided into four parts: cube material, block material, practice questions, and completion. This is done to lighten the weight of learning media. The Instagram filter was tested first using the meta spark player to see deficiencies that might not be appropriate when creating filters. Once deemed sufficient, the researcher registered the filters on the Meta Spark Studio website. Then in practice, the filter can be used using the link shared by the researcher or by visiting the researcher's Instagram page. Also, students are distributed target images that are used so that objects appear on the device screen when the filter is used.

Researchers make learning media at the development stage and develop research instruments. This instrument includes a validation questionnaire for media and material experts. Then there is a student and teacher response questionnaire. . Furthermore, the testing tools used include pre-test and post-test. The tool validator validates all of these tools. The test tool was then tested on SMP Negeri 1 Waringin Kurung Class IX students first to see the strength of the difference and the difficulty of the questions.

Researchers will test the teaching and learning media developed by the two experts, namely augmented reality-based mathematical media. This validation is for the purpose of determining the feasibility of materials developed before being tested in schools. In addition, researchers received suggestions and input from validators, which became the basis for researchers to improve the developed learning media. The repaired media will proceed to the implementation stage.

Next comes the implementation stage. At this stage, learning media based on augmented reality was tested directly during class VIII SMP Negeri 1 Waringinkurung. However, before applying learning media, students are first given pretest questions to see

their mathematical problem-solving abilities. In addition, posttest questions are provided after applying learning media to assess students' abilities in solving mathematical problems after using the media. All students and teachers involved in implementing the media under study were asked to fill out a questionnaire the researcher provided. The results of teacher and student feedback are used as data and calculated to determine the realism of learning materials based on augmented reality.

Evaluation is the last stage, where researchers observe the application of augmented reality-based learning media. Overall, there are no significant obstacles to learning. However, there are student devices that take a lot of time to respond to Instagram filters. However, this can be controlled by the researcher. Based on this, the developed media is considered suitable for use. Learning media made according to student and teacher responses are considered very good. So the researchers do not modify the final product.

According to the analysis that has been carried out, the results are obtained on augmented reality-based media. Namely, the feasibility of the media is carried out through validation or assessment from the media and material experts. Material experts, including language aspects, benefits aspects, material aspects, and content feasibility aspects, are validating several aspects. The results of the material expert validation calculations get an average percentage of 89.41% in the "Very Eligible" category. The results are presented in the following table:

Table 1. Material Expert Validation Results

Aspect	Total Score	Percentage	Criteria
Content Eligibility	53	88,33%	Very Feasible
Material	55	90%	Very Feasible
Benefit	64	93,33%	Very Feasible
Language	12	80%	Feasible
Total	228	89,41	Very Feasible

According to the table above, it can be seen that the assessment of material experts on learning the media obtains a percentage in the content feasibility aspect which includes media titles, essential competencies, and competency indicators of 88.33%, including the "Very Feasible" category. In the aspect of the material, which includes the material's relevance, format, presentation, support, and practice questions, the percentage of 90% is "Very Feasible". On the benefit aspect, which includes solving mathematical problems, it gets

a rate of 93,33% in the category "Very Feasible" In the aspect of language, which includes the use of language, it gets an assessment percentage of 80% in the category “Feasible"

While the validation by media experts includes aspects of augmented reality, aspects of programming, and aspects of the media display, the results of the material expert validation calculations get an average percentage of 86.33% in the "Very Feasible"category. The results are presented in the following figure:

Table 2. Media Expert Validation Results

Aspect	Total score	Percentage	Criteria
Media display	140	84,85%	Very Feasible
Programming	55	91,67%	Very Feasible
Augmented reality	64	85,33%	Very Feasible
Total	259	86,33%	Very Feasible

According to the table above, it can be seen that the media expert's assessment of learning media products gets a percentage in the aspect of media display which includes the initial appearance, text format, the use of colour, program appearance, and language worth 84.85% in the category "Very Valid" or "Very Feasible".

In the programming aspect, which includes usability, efficiency, and functionality, it gets a rating percentage of 91.67% in the "Very Valid" or "Very Feasible" category. In augmented reality which contains 3D objects, responsiveness, and user interaction, a rating percentage of 85.33% is included in the "Very Valid" or "Very Feasible" category.

The overall percentage was 89.41% as determined by materials experts and 86.33% by communication experts. Both are on the criteria of "Very feasible". The results of validating the two experts are considered "Very Valid" or "Very Feasible" for augmented reality-based learning media.

The practicality of the learning materials that the researchers developed at the pilot stage was evaluated based on student and teacher feedback. There were 24 students and one math teacher involved in this product trial. Several aspects considered include aspects of language, practicality, material presentation, and use and appearance. The calculation results of the students' answers reached an average rate of 87.95% in the "Very practical" category. In addition, the results of the teacher's answer calculation achieved an average rate of 89.09%. Category "Very Practical". The results are presented in the following table:

Table 3. Student Response Results

Aspect	Total Score	Percentage	Criteria
Appearance	312	86,67%	Very Practical
Usage	318	88,33%	Very Practical
Material Presentation	317	88,06%	Very Practical
Benefits	214	89,17%	Very Practical
Total	1161	87,95%	Very Practical

Table 4. Teacher Response Results

Aspect	Total Score	Percentage	Criteria
Appearance	15	100%	Very Practical
Usage	13	86,67%	Very Practical
Material Presentation	13	86,67%	Very Practical
Benefits	8	80%	Practical
Total	49	89,09%	Very Practical

Tables 3 and 4 show that students' responses to learning media products are assessed from the display aspect, including the media's appearance, writing, and language used. Obtain 86.67%, including the "Very Practical" criteria. Aspects of use include ease of use, instructions, and scene switching. Get a value of 88.33%, including the "Very Practical" criteria. In the aspect of presenting the material that contains understanding and practice questions. Received 88.06%, including the "Very Practical" criteria. As well as the aspect of benefits that includes solving mathematical problems. Received a percentage of 89.17%, including efficient criteria.

The results of the teacher's response, by loading the same indicators as the student response questionnaire, were that the display aspect had a rating percentage of 100% and the category was "Very Practical". While in the user aspect, it has a rate of 86.67% in the category "Very Practical". The element of presenting the material with a percentage of 86.67% is in the "Very Practical" category. Also, on the benefit aspect, with an assessment percentage of 80%, it is included in the "Very Practical" category.

Based on student responses, the rate was 87.95% and teacher responses were 89.05%. Both are in the criteria of "Very Practical". With the results obtained through student and teacher responses, augmented reality-based learning media is considered "Very Practical".

At the stage of implementing learning media products in schools, the effectiveness of augmented reality communication is evaluated based on student pretest and posttest assessment results to determine whether the students' ability to solve mathematical

problems during the pretest and after the posttest has increased. Twenty-four students became respondents in this product trial.

The capacity of the pupils to answer math problems increased, as shown by the outcomes of the pretest and posttest. After getting the results of the students' pretest and posttest, check the N-Gain score to determine whether there has been an improvement in the student's capacity to solve mathematical problems following the implementation of teaching and learning process utilizing learning media products. The following table displays the N-Gain score's findings:

Table 5. N-Gain Score Results

Description	Pretest	Posttest
Lowest Score	12	24
Highest Score	32	50
Amount	515	960
Average	21,46	40
Average N-Gain Score	0,66	
	Medium	
Percentage	66,23%	
	Effective enough	

The level of significance is calculated using the n-gain score test. The test obtained a result of 0.66. The n-gain score of 0.66 is 0.3 ≤ n-gain ≤ 0.7, with a moderate comparison. This indicates that students' mathematical problem-solving abilities increase in the medium category. The N-Gain Score results for each student are as follows:

Tablel 6. N-Gain Score Results for Each Student

N-Gain Score Limitation	Category	The number of students	Percentage
g > 0,7	High	8	33,33%
0,3 ≤ g ≤ 0,7	Medium	14	58,33%
g < 0,3	Low	2	8,33%
Amount		24	100%

According to Table 6, eight students experienced an increase in math problem solving ability. The growth is classified into three categories. The high-criteria has 8 students (33.33%); The average criterion had 14 students pass (58.33%), the low criterion increased by 2 students (8.33%).

Then for the one-way t-paired test, the t-table value = 15.25 and the t-table value = 1.71, which means t-table > t-table. This indicates an increase in students' mean posttest scores compared to the mean pretest scores. So, it is considered effective teaching and

learning media based on augmented reality which is applied to the Instagram filter at SMP Negeri 1 Waringinkurung.

The presence of augmented reality-based media positively impacts efforts to increase students' abilities in solving mathematical problems. The principle of AR helps students learn the concept of geometric shapes. This way, learning becomes more effective because students can see objects directly, and students don't have to imagine or redraw (Hendriyani et al., 2019).

CONCLUSION

By the description of the research results, some conclusions can be drawn; among others, the assessment of augmented reality-based teaching and learning media developed on Instagram filters to increase mathematical problem-solving abilities is considered "very feasible" where the average value of the proportion is 89.41% of material experts and 86.33% from media experts. So, the development of learning media that was carried out was considered "very feasible" to be used during the learning process.

Then the response from learning media that is "very good" has an average proportion of 87.95% of student responses and an average proportion of 89.09% of teacher responses. Thus, developing instructional media is considered "very practical" during learning.

Furthermore, there was an increase in students' ability to solve mathematical problems in the "moderate" category regarding the application of instructional media with an n-gain score of 0.66 or 66.23% based on the pretest and posttest results marked by an average difference. In addition, there was an increase between the students' pretest and posttest, with the paired t-test obtaining a value = 15.25 and a t-table value = 1.71, which means t-test > t-table. Thus, learning media development is considered "very effective" for use during learning.

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