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AUGMENTED REALITY-BASED LEARNING MEDIA TO IMPROVE MATHEMATICAL PROBLEM-SOLVING ABILITY IN ELEMENTARY SCHOOLS

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Abstract

The importance of mathematics in everyday life is the reason students are expected to understand and be able to apply the mathematics learning they have received at school. One of the abilities in mathematics is problem-solving ability. Abstract mathematics requires concrete learning media so that it is more acceptable to students in elementary schools during learning. The media that is currently frequently used is IT-based learning media. One is augmented reality, which integrates two-dimensional media into three dimensions. This research tests whether increased reality-based learning media can improve problem-solving abilities. The data analysis used is the normality test, paired sample t-test, and normalized gain test. The research results show that augmented reality-based learning media can improve students' problem-solving abilities.

Keywords: Learning media, Augmented Reality,Problem-solving ability, Mathematics, Elementary School

INTRODUCTION

Mathematics is a science that has a significant role in various activities carried out by humans in their lives (Suandito, 2017). Human activities in everyday life cannot be separated from using and applying concepts in mathematics. As a universal science, mathematics cannot be separated from other scientific disciplines in human life. The importance of people learning mathematics cannot be separated from their role in life; for example, a lot of information and ideas are conveyed in mathematical language, and many problems can be presented in mathematical models (Perdana & Suswandari, 2021). Someone is used to thinking systematically, scientifically, using logic, and critically, and can increase their creativity by studying mathematics. Mathematics is essential both as a tool, as knowledge (for scientists), as a guide to thought patterns, and as an attitude shaper. Mathematics is so essential that this, of course, becomes a challenge for teachers in teaching mathematics in the classroom. Mathematics is the basic knowledge students need to support their learning success in pursuing higher education (Abi & Gella, 2019). In general, mathematics is required by everyone in everyday life. Therefore, it is highly expected that students will master mathematics because it is a means of scientific thinking that students need. Although there are still students who consider mathematics to be a complex subject (Heryan & Zamzaili, 2018).

Problem-solving ability is one of the focuses in mathematics learning, which includes closed issues with a single solution, open issues with a non-single solution, and problems with various ways of solving. Developing skills in understanding subjects, creating mathematical models, solving problems, and interpreting answers is necessary to improve problem-solving abilities.

Trends International Mathematics and Science Study (TIMSS) in 2015 stated that Indonesia was ranked 44th or sixth from the bottom compared to the 49 countries that were members of TIMSS. Obtaining these results is a sign that students' abilities in mathematics are classified as below or low when compared with other countries. Apart from the TIMSS survey, there was also a survey from the Program for International Student Assessment (PISA) in 2018, which stated that Indonesia got a mathematics score of 379. Indonesia experienced a decline; in 2015, it scored 386. So, in 2018, Indonesia was ranked 73rd. 79 countries (Hawa & Putra, 2018).

The results of surveys conducted by TIMSS and PISA must be used as material for improvements in the implementation of mathematics learning and efforts to develop the quality of education from several main components, one of which is teachers. A quality learning process depends on the quality of a teacher because the teacher holds and plays an essential role in the implementation of learning. As stated (Zahroh, 2015), teachers determine student success in teaching and learning activities.

The 2000 Principles and Standards for School Mathematics revealed that five standards describe the relationship between mathematical understanding and mathematical competence that students must carry out, including problem-solving (Jahnke, 2019). Apart from that, one of the general objectives of mathematics learning formulated by the National Council of Teachers of Mathematics or NCTM (2000) is for students to have the ability to solve problems. Therefore, teaching is needed to stimulate students' abilities to solve mathematical problems. In the school mathematics curriculum, the objectives of mathematics lessons include that students can face changes in world conditions that are constantly developing by acting based on thinking logically, rationally, critically, carefully, honestly, and effectively. This cannot be achieved only through rote memorization, routine problem-solving practice, and ordinary learning. Still, it must be done using appropriate methods or approaches so that students can think critically and logically and solve problems with an open, creative, and innovative attitude.

Students think that mathematics is just one of the complex subjects and has nothing to do with the pattern of life that they are living in the area (Sari & Ahmad, 2022). There is a tendency for the learning environment in the classroom to be separate from their daily life environment, one of the factors being that teachers do not integrate daily activities into the learning process. They think it is not essential to be good at mathematics. Students who feel inadequate in mathematics tend to feel discouraged in learning and make less effort to improve the quality of their education. They consider mathematics a science that is too abstract to be applied in life, even though there is material related to everyday life. However, in concept, they believe it is only an application of mathematics. One of the reasons why mathematics material is complex for students is because teachers convey mathematics material to students using an abstract approach without any assistance using learning media.

Every mathematical concept can be understood perfectly if presented in a concrete form, so learning media is needed to explain these concepts concretely by using Augmented Reality technology (Ulia, 2018), which is similar to natural objects virtually right in the image on paper. Many teachers do not understand how the learning process will be implemented using technology. Therefore, learning media innovation is needed to improve students' problem-solving abilities. Moreover, Indonesia is currently preparing to face the era of Society 5.0. Society 5.0, or what is known as Society 5.0, is a concept launched by the Japanese government. Many challenges will be faced in the 5.0 revolution era, which must be packaged carefully to align with current developments. One is a curriculum projection of the ability to apply technology in that era (Rahayu, 2021). Augmented Reality-based media is one of the concepts summarized in the age of Society 5.0. Augmented reality can be used to combine natural objects with the digital world without changing the object's shape (Saurina, 2016). By utilizing AR technology to improve problem-solving abilities, the development of Augmented Reality-based media is deemed appropriate because of current technological developments. Augmented Reality-based learning contains materials and practice questions that are interactive and easily accessible to students.

Science and Technology is increasingly developing along with the times. This makes a significant contribution to developing educational technology. Innovation in the field of education is also increasing. One technology in the world of education is the use of Augmented Reality (AR). Augmented Reality (AR) combines the virtual world with the natural world to produce information from data taken from a system on designated natural objects, making the boundary between the two increasingly thin (Balandin et al., 2010). Augmented Reality (AR) is also called "virtual reality" because it gives the effect of seeing real media around you with a relatively high level of reality (Pawicara & Conilie, 2020). AR has interactive properties as a learning medium that can attract students' attention in studying learning material (Balandin et al., 2010b). AR is used through pages printed with animation media, which can move students into an interactive virtual environment (Pramono & Setiawan, 2019). Even though Augmented Reality technology is not new, its potential in education has not been utilized and developed correctly. Learning innovation is needed to improve student learning outcomes, especially problem-solving abilities. Based on the explanation above, Augmented Reality (AR))-based media is expected to be a solution and innovation in mathematics learning to improve students' problem-solving abilities.

METHOD

The method used in this research is quantitative. Quantitative methods are often called traditional, positivistic, or discovery methods. It is called quantitative because the research data is in numbers, and the analysis uses statistics. The experimental method is used to find the effect of specific treatments on others under controlled conditions (Sugiyono, 2012). This quantitative understanding

is generally carried out on specific populations or samples. Research instruments were used to collect data.

The research used is pre-experiment design research. In the pre-experimental design, external variables influence the formation of the dependent variable where the sample is not chosen randomly. One Group Protest - Posttest is a design that uses a pretest at the beginning or before treatment and provides a posttest at the end or after treatment (Sugiyono, 2018). The reason for using this research design is that only one class is used, so there are no other classes to compare. In this design, a pretest will be given before treatment, and a posttest will be granted at the end. In this way, more accurate results will be known because there is a comparison between the conditions before and after treatment.

RESULTS AND DISCUSSION

The research carried out in class V in mathematics learning was to test whether there was a difference in problem-solving abilities between before and after learning using Augmented Reality-based learning media using the normality test, paired sample t-test, and normalized gain test. The following are the results of statistical tests that have been used. The normality test is used to determine whether the sample's initial state data is normally distributed. If the data is normally distributed, then the statistical test is parametric. Meanwhile, the statistical test uses non-parametric tests if the data is not normally distributed.

Tabel 1. Output of Tests of Normality

	Kolmogorov-Smirnov[a]		
	Statistic	**df**	**Sig.**
Ekspositori	.092	27	.200*

The normality test was carried out with SPSS using the Kolmogorov-Smirnov Test. With a significance degree of 5%, if the sig value. If the Kolmogorov-Smirnov test is > 5%, then H0 is accepted, and if the sig value is < 5%, then H0 is rejected (Kaselin et al., 2013). It was found that the data was normally distributed because it had a sig value > 0.05 so it was normally distributed. Based on Table 1, sig = 0.081 > 0.05 (α=5%=0.05), H0 is accepted, meaning it is usually spread.

The Paired Sample Test was used to compare the average level of students' problem-solving abilities before and after using Augmented Reality-based media. The pretest and posttest results showed that the average pretest result was 38.15. Meanwhile, the average posttest result was 63.33.

Tabel 2. Output of paired sample t test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig.(2-tailed)
Pair 1	Pretest-Post Test	-25,185	16.022	3.083	-31.532	-18.847	-8.168	26	.000

Ho is accepted if the lower value is negative, the upper value is positive, or the sig value (2-tailed)>α. From the results of the SPSS testing that has been carried out, it is found that Lower and Upper are negative or sig, (2-tailed) = 0.000 <0.05, so Ho is rejected, and Ha is accepted, thus meaning that there is a difference before and after using Augmented Reality-based media. After knowing that there is a difference in the values obtained after the pretest and posttest, the next step is to carry out a normalized gain test. The normalized gain test was conducted to determine the increase before and after media use. The gain test is carried out to provide an overview of the increase in learning outcomes in general. The average classical increase in the gain test results was 0.42 with medium criteria. You can see the following table to determine the suitability of calculating normalized gain test results using SPSS.

Tabel 3. Output of *Gain* ternormality

	N	**Minimum**	**Maksimum**	**Mean**	**Devitiation**
Ngain_skor	27	0,00	1,00	0,42	0,26
Ngain_persen	27	0,00	100,00	41,51	26,03
Valid N (listwise)	27				

Based on the gain test results in Table 3, calculation results have been obtained to conclude that augmented reality-based media can improve elementary school students' problem-solving abilities in mathematics learning. Based on the research results, it was found that increased reality-based learning media can influence and enhance problem-solving skills in students' mathematics learning in elementary schools. Increased reality media is a dancing media; when learning begins, students are already curious about this media; when increased reality media is used in learning, students become more interested and amazed if this media exists. Increased reality media as an integration between digital and reality where changing from two-dimensional to 3-dimensional media supports abstract mathematics learning. The following is documentation on the use of AR media in learning..

Figure 1. Use of augmented reality media

Learning using media is very effective; as a current trend, digital media has become an innovation that teachers can use in learning as research that has been carried out by (Siregar & Sitepu, 2023) shows that learning using media as a game influences student learning activities. The use of media in education can be applied in various ways. Missals are combined with learning models or with specific approaches. One approach that can be used in games. Research results have shown that it is effective(Ulfa et al., 2022) (Wachdani & Thohir, 2022) and has obtained perfect perceptions (Nabila et al., 2023). Augmented reality-based learning media can improve problem-solving abilities. The indicators for problem-solving are identifying problems, planning solutions, resolving issues, and checking again (Bachtiar & Susanah, 2021)

CONCLUSION

The development of Augmented Reality-based media is deemed appropriate because of current technological developments. Science and Technology (IPTEK) is increasingly developing along with the times. This makes a significant contribution to developing educational technology. Innovation in the field of education is also increasing. One technology in the world of education is the use of Augmented Reality (AR). Augmented Reality (AR) combines the virtual world with the real world to produce information from captured data. The research showed that the sample had a normal distribution, indicated by a sig value > 0.05. Meanwhile, the results of the paired sample t-test show that there is a difference in problem-solving abilities before and after using Augmented Reality based media because sig, (2-tailed) = 0.000 < 0.05, and the increase that occurs is obtained by a gain test result of 0.42 with the criteria increase in the medium category.

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