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Augmented Reality Based Student Worksheets to Improve Understanding of 3D-Shapes Concepts for Fifth Grade of Elementary Schools

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ABSTRAK

Permasalahan siswa yang sulit mengerti konsep bangun ruang pada pelajaran matematika. Siswa cenderung sulit memahami materi karena tidak ada media pembelajaran yang sesuai dengan karakteristik siswa. Penelitian yang bertujuan untuk mengembangkan LKPD berbasis augmented reality terhadap pemahaman konsep bangun ruang peserta didik kelas V di SD. Studi pengembangan ini menggunakan model ADDIE yaitu analisis, perancangan, pengembangan, implementasi, dan evaluasi. Studi ini mengambil subjek LKPD berbasis augmented reality, sedangkan objek penelitian pengembangan adalah validitas isi media, isi materi, kepraktisan penggunaan, dan efektivitas media. Metode pengumpulan data yaitu dengan rating scale dan tes. Instrumen yang dipergunakan untuk mengumpulkan data yaitu lembar rating scale, dan lembar tes. Hasil penelitian menunjukan bahwa LKPD berbasis augmented reality yang memperoleh indeks kualifikasi validitas tinggi, materi pada isi media LKPD berbasis augmented reality yang telah dihasilkan memperoleh indeks kualifikasi validitas tinggi, tingkat pencapaian respon praktisi/guru mendapat kualifikasi sangat baik, tingkat pencapaian respon peserta didik terhadap media LKPD berbasis augmented reality mendapat kualifikasi sangat baik, dan nilai signifikansi pada uji-t berkorelasi memperoleh skor sebesar sebesar 0,000 < 0,05, sehingga media LKPD berbasis augmented reality efektif guna meningkatkan pemahaman konsep bangun ruang peserta didik kelas V di Sekolah Dasar.

ABSTRACT

The problem of students who have difficulty understanding the concept of building a space in mathematics lessons. Students tend to find it difficult to understand the material because there is no learning medium that suits the characteristics of students. The research aims to develop an augmented reality-based LKPD on the understanding of the concept of building a classroom for grade V students in elementary school. This development study uses the ADDIE model, namely analysis, design, development, implementation, and evaluation. This study takes the subject of augmented reality-based LKPD, while the object of development research is the validity of media content, material content, practicality of use, and media effectiveness. The data collection method is by rating scale and test. The instruments used to collect data are rating scale sheets, and test sheets. The results of the study showed that the augmented reality-based LKPD obtained a high validity qualification index, the material in the content of the augmented reality-based LKPD media that had been produced obtained a high validity qualification index, the level of achievement of practitioner/teacher response received very good qualifications, the level of achievement of students' response to augmented reality-based LKPD media obtained very good qualifications, and the significance value on the correlated t-test obtained a score by 0.000 < 0.05, so that augmented reality-based LKPD media is effective in increasing the understanding of the concept of building a classroom for grade V students in elementary schools.

1. INTRODUCTION

The use of technology to support the learning process is not a new thing in the world of education. At this time, the use of technology in education is mandatory (Gumelar & Dinnur, 2020; Raudatussolihah,

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2022). One of the most popular technologies today is augmented reality (AR). AR is a technology that combines two-dimensional virtual objects and real-world conditions that can be displayed in real time..The use of AR in learning is very useful and fun (Merliana, 2018; Ulfadilah et al., 2021). AR is able to provide an image, either in two-dimensional or three-dimensional form which is useful for developing students' understanding of the concept of mathematical spatial geometry material. Therefore, the use of LKPD based on augmented reality (AR) in spatial geometry material is expected to be able to improve students' conceptual understanding of spatial geometry concepts (Haryani & Triyono, 2017; Qorimah & Sutama, 2022). This is due to several factors, namely (1) by using AR technology in LKPD, students will be more interested and motivated in participating in learning. (2) The use of AR will maximize the use of smartphones by students, so as to minimize the negative use of smartphones. (3) Reducing the use of monotonous teaching materials, so as to motivate students more in the learning process.

The field of mathematics is still considered one of the most difficult and unpleasant fields of study to learn. This causes students' learning outcomes in mathematics to be quite low (Nurhayanti et al., 2021; Salafudin, 2015). This is based on data from the Trends in International Mathematics and Science Study (TIMSS) in 2011 which showed that Indonesia's mathematics achievement score was ranked 38 out of 42 countries. Based on these data, it can be said that students' conceptual understanding in the field of mathematics is still low. The difficulty in understanding the concept is caused by several factors, both from students and from teachers. Problems raised by teachers include lack of mastery in learning models, ineffective use of media or teaching materials, and using inappropriate methods or approaches (Hidayat, 2021; Masruni, 2021). While the problems raised by students are, lack of motivation and enthusiasm in learning. So that it causes low learning outcomes obtained by students.

Based on an interview conducted with the homeroom teacher of grade V of SD Negeri 3 Lelateng, it was found that the teacher's efforts in explaining learning materials used the help of books, teaching aids, and sometimes used learning videos obtained from YouTube. The homeroom teacher of grade V of SD Negeri 3 Lelateng also added that the use of technology in learning was limited to the use of power points, YouTube, and assessments using Google forms (Kulbi, 2019; Nurfalah, 2019).Therefore, students are given permission to bring smartphones, as long as it is intended to support the learning process. In addition, based on the results of interviews conducted with the homeroom teacher of grade V SDN 3 Lelateng, it was found that teachers had difficulty in fostering interest, motivation, and enthusiasm in learning. This resulted in the majority of students lacking in understanding mathematics learning materials, especially in understanding the concept of spatial geometry materials (Rahayu & Dahlan R, 2021; Ramadhani & Muhroji, 2022).

The above explanation is reinforced by a document study of students' understanding of the concept of spatial shapes as seen from the results of class V student tests which are useful for supporting the results of observations that have been carried out at SD Negeri 3 Lelateng. The results of the document study obtained at SD Negeri 3 Lelateng stated that the percentage of students who had not met the KKM value in the basic concept of spatial shapes was 64%. Of the total number of students, 22 students, 14 students had not yet achieved the KKM value in the field of mathematics, which was 65. This shows that the ability of the basic concept of spatial shapes of class V students in learning mathematics on spatial shapes is still relatively low with a percentage of 64%.

The efforts offered to overcome these problems are to develop creative and innovative teaching materials to support the learning process. One of the teaching materials that can be developed is LKPD (Destiara et al., 2021). This research is relevant to be conducted because there are already several experts who have conducted similar research. The AR-based LKPD development research that was conducted the percentage obtained on the LKPD aspect is 95%, while on the Inquiry aspect it is 90%, on the AR aspect it is 98.66%. and for the material aspect it is 93.33%. Based on the results obtained, the average percentage obtained by learning experts is 94.25% and is stated as very valid.

The novelty of this research lies in the development of innovative and interactive Augmented Reality (AR)-based Student Worksheets (LKPD) for spatial geometry material for fifth grade elementary school students. This research not only utilizes AR technology to increase students' interest and motivation in learning mathematics, but also offers a more efficient approach in utilizing the use of smartphones positively in the learning environment (Haryani & Triyono, 2017; Ropawandi et al., 2022). Unlike conventional methods that are often monotonous and less effective, AR in LKPD provides a more dynamic learning experience with realistic two- and three-dimensional visualizations. The results of previous studies showed high validity in the aspects of LKPD, Inquiry, AR, and materials, with an average validation percentage of 94.25%, proving the great potential of using AR in improving understanding of spatial concepts. In addition, this study contributes to practical solutions to overcome students' low understanding of mathematics by providing creative and varied teaching materials. The integration of technology in LKPD is expected to answer the challenges of mathematics learning faced by teachers and students, as well as

encourage the adoption of technological innovation in elementary education (Prabowo, 2021; Supiase et al., 2023).

LKPD can be one of the efforts to facilitate the instillation of material concepts through varied learning activities..Therefore, it can be said that LKPD can help students understand the mathematical concept of cube geometry material (Indriani et al., 2023; IN Sari & Sulisworo, 2023). The use of E-LKPD can have an impact on the results of the average posttest scores of students who experienced an increase in results after using E-LKPD. To increase student motivation and enthusiasm in learning, it seems necessary to innovate in LKPD, especially in integrating technology in LKPD.

In line with the research on the development of LKPD material on the volume of irregular geometric shapes using the project based learning model in grade V of elementary school which obtained an average total validation result of 3.41 with details on the aspect of content feasibility of 3.66, the aspect of language feasibility of 3.06, the aspect of activity feasibility of 3.55, the aspect of display feasibility of 3.33, the aspect of presentation feasibility of 3.33 and the aspect of implementation and measurement of 3.55 with very good criteria. Based on the problems and data that have been presented, a development research (Research and Development) was carried out with the title Development of Augmented Reality-Based Student Worksheets to Improve Understanding of the Concept of Geometric Shapes in Grade V of Elementary Schools. The research aims to develop LKPD based on augmented reality for the understanding of the concept of geometric shapes of grade V students in elementary school.

2. METHOD

In this development research, Research and Development research was used with the ADDIE model (analysis, design, development, implementation, evaluation) (Aldoobie, 2015). The ADDIE model is a model that is arranged in a programmed manner with a systematic sequence of activities in an effort to solve learning problems related to learning resources that are in accordance with the needs and characteristics of the learner. Product trials are conducted using a one group pretest and posttest design. In this design, the results of the treatment given can be known more accurately because it is done by comparing the condition of the object before and after the treatment is given.

The subject of this study is AR-based LKPD on the mathematical content of spatial geometry material. This LKPD will be tested by several experts, practitioners, and student responses. The object of this research trial is the validity and practicality of LKPD based on augmented reality on the mathematical content of spatial geometry material. For the implementation stage, the subjects of the research trial are fifth grade students of SD Negeri 3 Lelateng and the object of the research trial is the understanding of students' spatial geometry concepts. The types of data used in this development research are quantitative data and qualitative data.

Quantitative data is data that can be calculated as a numeric variable. In this study, quantitative data is data obtained through a questionnaire or questionnaire that is converted into a value. Qualitative data is used in the development of AR-based LKPD, namely the results of interviews, assessment results, input in the form of criticism, suggestions and improvements from reviews of experts and users of student worksheets. The data collection method used in this AR-based LKPD development research is a non-test method, namely using a questionnaire or questionnaire. A questionnaire or questionnaire is a data collection technique that is carried out by giving a set of written questions or statements to respondents to be answered. The instrument used in this study is a rating scale. Before the instrument is made, an instrument grid is first made. The instrument grid in this study aims to determine the design, feasibility, and effectiveness of AR-based LKPD teaching materials. The research instrument grid can be seen in Table 1, Table 2, Table 3, Table 4 and Table 5.

Table 1. The Learning Material Expert Instrument Grid

Aspect	Component
Curriculum	Suitability of material to learning outcomes.
	Suitability of the material to learning objectives.
Material	Material breakdown
	Depth of material.
	Clarity of material
Language	Use of standard language.
	Paragraph accuracy.
	Correctness of sentence structure
	Ease of understanding sentences.
Evaluation	Suitability of evaluation to material.

Table 2. The Learning Media Expert Instrument Grid

Aspect	Component
Appearance	The attractiveness of the product display.
	Suitability of design to student characteristics.
Text	Conformity of font size on the product.
	Readability of text on products.
	Appropriate font type on the product.
Picture	Clarity regarding the image on the product.
	Conformity of images to the product.
Color	Text color matching on the product.
	Color conformity of the image to the product.
Layout	The text layout is consistent on every page of the product.
	Component layout is right on every page of the product.
Audio	The suitability of the background sound used in the animated video.
Use	Ease of use of the product.

Table 3. The Practitioner Response Instrument Grid

Aspect	Component
Operation	Ease of use of the product.
	Product usage instructions.
	Product content breakdown.
	Clarity of product instructions
	Practicality of product use.

Table 4. The Small Group Learner Instrument Grid

Aspect	Component
Operation	Ease of use of the product.
	Product usage instructions.
	Product content breakdown.
	Clarity of product instructions
	Practicality of product use.

Table 5. The Grid of Instruments for Understanding the Concept of Spatial Buildings

No	Learning Outcomes	Indicator
1	Comparing the characteristics between geometric shapes.	Given a question, students analyze the characteristics of a cube.
		Given a picture, students analyze the geometric shape of a cuboid.
		Given a question, students analyze the differences in characteristics between the geometric shapes of a rectangular pyramid and a rectangular prism.
2	Recognizing spatial visualization of geometric shapes.	Given questions, students are able to analyze cuboid nets.
		Presented with questions, students are able to make rectangular pyramid nets.
		Presented with questions, students are able to create rectangular prism nets.
3	Explaining and determining the volume of geometric shapes using volume units and the relationship between cube powers and cube roots.	With pictures, students are able to analyze the volume of a cube using unit cubes.
		With pictures, students are able to analyze the volume of cuboids using unit cubes.
		With story problems, students are able to solve problems regarding the volume of a cube.
		With story problems, students are able to solve problems regarding the volume of cuboids.

The instruments that have been created are then tested by experts, then analyzed using the formula Gregory. The validity of the media is also tested to experts and analyzed using the Aiken formula. The practicality of the product is assessed by practitioners (teachers) the value obtained will be calculated using

the mean formula. Analysis of the effectiveness of AR-based LKPD on students' conceptual understanding using the correlated t-test formula. The effectiveness test was conducted to prove the effectiveness of AR-based LKPD to improve students' conceptual understanding.

3. RESULT AND DISCUSSION

Result

This study produced Augmented Reality-based LKPD to improve the understanding of the concept of spatial geometry of fifth grade elementary school students. This study was conducted in five stages in accordance with the ADDIE development model, namely the analysis stage (analyze) at this stage several analyzes were carried out to determine the condition of the school and mathematics learning in grade V of SD Negeri 3 Lelateng. The analysis carried out included analysis of LKPD needs in learning activities, analysis of learning facilities, analysis of student characteristics, and content analysis. Based on the results of the analysis, it was found that the use of media and teaching materials in learning was still very monotonous, making students easily bored and unable to improve their learning abilities. Therefore, teaching materials are needed that are able to motivate students and help students in learning. The second stage is product design (design) at this stage media design was carried out by creating a LKPD flowchart and compiling research instruments. The media design that was developed can be seen in Figure 1.

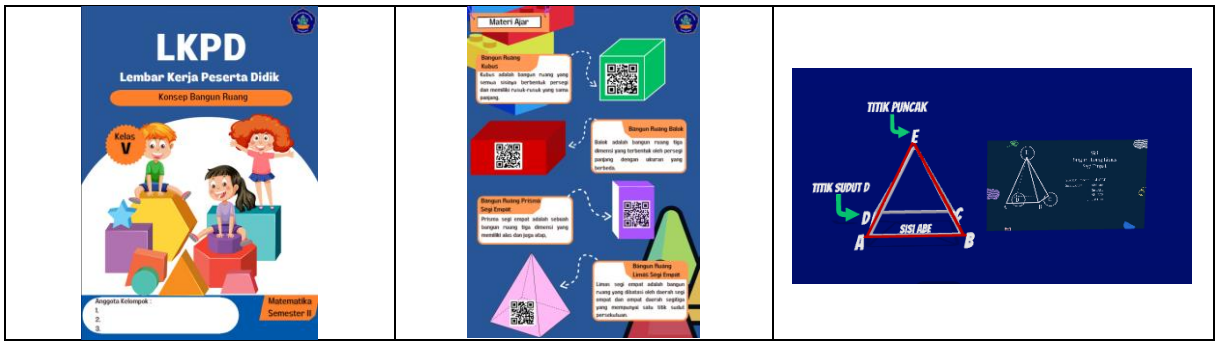

Figure 1. The LKPD Media Design Based on Augmented Reality

The third stage is product development (development) researchers carry out the complete manufacture of products according to what has been designed at the design stage. So that the result of the development stage is a learning media product that has been prepared. At this stage, instrument validity and content validity tests are also carried out by experts. The results of expert assessments can be seen in Table 6.

Table 6. The Validity and Practicality Assessment Results

No	Validity	Score	Qualification
1	Validity of Learning Media	0.92	High Validity
2	Validity of Material	0.92	High Validity
3	Teacher Practicality	3.8	Very good
4	Media Practicality By Students	3.97	Very good

Based on Table 6, the validity analysis using the Aiken V formula which then obtained a score from media experts of 0.92 and from material experts of 0.92 with the predicate/qualification of "high validity". In the practicality analysis using the mean formula which then got a score of 3.8 from the results of practitioner responses and 4.00 from student responses with the predicate/qualification of "very good".

The fourth stage is implementation when the developed product has been completed and its feasibility has been tested by each expert in their field. Then it is continued with the use of AR-based LKPD in learning in the mathematics content of class V SDN 3 Lelateng. The implementation of AR-based LKPD was carried out to determine the influence of AR-based LKPD teaching materials and their effectiveness. In the field trial, the samples taken were class V students of SDN 3 Lelateng. Before the correlation t-test analysis was carried out on the data from the pretest and posttest results of students, there were prerequisite tests that had to be carried out. The prerequisite tests carried out in this study included the normality test of data distribution and the homogeneity test of variance. The results of the normality test are shown in Table 7.

Table 7. The Data Distribution Normality Test

	Kolmogorov-Smirnov			Shapiro Wilk		
Data	**Statistics**	**Df**	**Sig.**	**Statistics**	**df**	**Sig.**
Pre-test	0.174	29	0.025	0.932	29	0.062
Post-test	0.138	29	0.164	0.963	29	0.389

Based onTable 7, It is known that the data distribution is known to have a normal distribution. Furthermore, a homogeneity test is carried out as one of the prerequisite tests for analysis which is carried out with the help of IBM SPSS 25 for Windows software. The homogeneity test is shown in Table 8.

Table 8. The Homogeneity of Variance Test

Learning outcomes			
Levene Statistics	**df1**	**df2**	**Sig.**
1.511	1	56	0.224

Based on Table 8, it is known that the homogeneity test shows that some of the data in this study are homogeneous, so it can be continued to the hypothesis testing stage. The complete analysis results are presented in Table 9.

Table 9. The Hypothesis Testing

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Learning Outcomes – Group	17.621	6.264	1.163	15.238	20.004	15.147	28	0.000

Based on Table 9, which has been displayed, it is known that the sig. value (2-tailed) is 0.000 <0.05, then H_0 is rejected and H_1 is accepted. So it can be concluded that there is a significant difference in students' understanding of the concept of spatial shapes before and after being taught using LKPD based on augmented reality. So the use of this LKPD is effective in improving students' understanding of the concept of spatial shapes.

The final stage is evaluation. The evaluation stage is used to determine the feasibility and achievement of the objectives of developing AR-based LKPD as a tool in the learning process in the mathematics content of class V spatial geometry material. At this evaluation stage, it is carried out using the assessment basis of media expert validation, material experts, practitioner response tests, and small group trials of AR-based LKPD products so that the advantages and disadvantages of the product can be identified so that actions can be taken for improvement that can make the product better in the future.

Discussion

This development research produces LKPD based on augmented reality for grade V elementary school students. The development of LKPD based on augmented reality was carried out to improve the understanding of spatial figures of grade V elementary school students (Mida Astarina et al., 2023; Mursyidah, D. & Saputra, 2022). AR-based LKPD is beneficial for students, namely providing ease of use, helping students understand the material and providing satisfaction. LKPD assisted by augmented reality has several advantages such as being more interactive, effective in use, can be implemented widely in various media, and can make the learning process more enjoyable and make it easier for students to understand the material.

Efforts to achieve effective learning, the use of teaching materials in learning is very necessary, one of which is the use of student worksheets (LKPD) to support the learning process. To increase the attractiveness of students in the learning process, updates are needed in LKPD (Ayuditiasni Dewi et al., 2023; Nirmayani, 2022). One of the innovations that can be used is the integration of LKPD with technology, one of which is AR..Collaboration between LKPD and AR technology is expected to be able to increase students' interest and motivation in the learning process, thus having an impact on students' learning outcomes.The use of AR in education is usually used to convey information with visual displays supported

by audio and video. The use of AR in learning is indeed very rare, but it is able to connect, provide information, and channel information so that it can make the learning process effective, interesting, and efficient.

In the learning process, both offline and online learning, the use of teaching materials or learning media is very necessary to support the learning process. However, the use of teaching materials is very rare, the use of teaching materials is more using videos or textbooks, so that students are less interested in participating in learning (Sriyulianingsih et al., 2023; DST Wahyuni & Hastuti, 2023). In line with the theory of cognitive development according to Jean Piaget, which states that children aged 6-12 years are at the concrete operational stage. Where in the concrete operational stage, children are able to understand existing concepts with the help of real objects..The age range of the concrete operational stage is in accordance with the age of elementary school students. Based on the description of the problem, the solution that can be offered is the development of interesting and innovative teaching materials or learning media to overcome student boredom (Januarisman & Ghufron, 2016; Tastin et al., 2021). One of the teaching materials that can be developed is AR-based LKPD containing 3D images and 2D animated videos that can attract students' interest in the learning process and students are able to understand mathematical concepts well and correctly, especially in spatial geometry material.

Several researchers also studied the same thing. The results of this relevant research can provide an overview of the feasibility of research on AR-based LKPD research to improve conceptual understanding of spatial building materials in grade V of elementary school (Putri & Agustika, 2022; NPCO Wahyuni & Agustika, 2021). Research entitled "Development of Integrated Thematic Student Worksheets (LKPD) Integrating Strengthening of Character Education (PPK) and Literacy of Elementary School Students in Semarang City". Based on the results of the research conducted, it was found that LKPD is very effective when used as teaching materials in elementary schools. The second research entitled "Development of Augmented Reality-Based LKPD in the Practical Method of Sense Organ Material to Improve Students' Mastery of Concepts and Science Process Skills"(IN Sari & Sulisworo, 2023).Based on the results of the study, it was found that AR-based LKPD is very effective when used as learning materials.

Based on the results of research conducted by several other researchers, it can be concluded that the use of Augmented Reality-based LKPD can improve students' understanding of spatial concepts in the mathematics learning content of grade V elementary school. improve students' understanding of the concept of spatial shapes in the mathematics learning content of grade V SD. Students become more motivated and interested in participating in teaching and learning activities and are able to understand the material well through the use of LKPD based on augmented reality (Logayah et al., 2023; Rahmawati et al., 2021). LKPD based on augmented reality is able to motivate teachers in using and developing digital media/teaching materials to be used in learning and is able to create meaningful learning. LKPD based on augmented reality also helps teachers in implementing learning, especially in the mathematical content of spatial building material for grade V elementary school (Indriani et al., 2023; IN Sari & Sulisworo, 2023). The media developed also has a drawback, namely the material in the augmented reality-based LKPD can only be accessed via electronic devices in the form of mobile phones with internet access. This drawback can be overcome by using mobile phones together with the group.

This research provides significant implications for the world of education, especially in mathematics learning in elementary schools. The development of LKPD based on Augmented Reality (AR) has proven effective in improving the understanding of spatial concepts among fifth grade students. The use of AR technology in LKPD not only makes learning more interesting and interactive, but also increases student motivation and involvement in the learning process. Thus, teachers are expected to be more motivated to integrate technology into their learning methods, which can ultimately create a more dynamic and innovative learning environment.

Although this study shows positive results, there are limitations that need to be considered. One of them is the need for access to electronic devices such as smartphones and a stable internet connection. This can be an obstacle in schools that have limited technological facilities or for students who do not have easy access to these devices. In addition, the use of AR in LKPD still requires further adjustment and development so that it can be implemented optimally in various learning conditions. Another limitation is the possible lack of teacher readiness in using this new technology, so ongoing training and support are needed to ensure that they can utilize AR-based LKPD effectively in the learning process.

4. CONCLUSION

Based on the research that has been done, it can be concluded that the use of this LKPD is effective in improving students' understanding of the concept of spatial shapes. Students become more motivated and interested in participating in teaching and learning activities and are able to understand the material

well through the use of LKPD based on augmented reality. LKPD based on augmented reality is able to motivate teachers in using and developing digital media/teaching materials to be used in learning and is able to create meaningful learning. LKPD based on augmented reality helps teachers in implementing learning, especially in the mathematical content of spatial shapes for grade V elementary school.

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