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Augmented Reality-Oriented Problem-Based Learning in Natural Science Materials

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ABSTRAK

Permasalahan yang muncul dari kesulitan siswa dalam mengikuti proses pembelajaran dan mengerjakan media dalam waktu yang lama membuat kemampuan siswa menjadi rendah. Hasil belajar siswa rendah karena kurangnya pengetahuan siswa menjadi masalah utama dalam pembelajaran. Untuk membantu meningkatkan hasil belajar siswa dapat dibantu dengan menggunakan media pembelajaran, penelitian ini menggunakan media pembelajaran augmented reality. Penelitian ini bertujuan untuk merancang pembelajaran berbasis masalah berbasis augmented reality pada materi IPA kelas V. Penelitian ini menggunakan model ADDIE dan metode penelitian ini adalah kuantitatif. Subyek dalam penelitian ini terdiri dari 1 ahli media, 1 ahli desain dan 1 ahli isi, 3 siswa sebagai uji coba individu, 9 siswa sebagai uji coba kelompok kecil, dan 23 siswa sebagai uji coba lapangan. Teknik pengumpulan data yang digunakan meliputi deskripsi kualitatif, deskripsi kuantitatif, dan statistik inferensial t-test. Hasil penelitian adalah (1) perancangan augmented reality dengan tahapan model ADDIE, (2) ahli media mendapat skor 94,4% kualifikasi sangat baik, uji ahli desain mendapat skor 92% kualifikasi sangat baik, uji ahli isi mendapat skor 98, 6% kualifikasi sangat baik, uji coba individu memperoleh skor 96,47% kualifikasi sangat baik, uji coba kelompok memperoleh skor 95,57% kualifikasi sangat baik, (3) berdasarkan uji keefektifan itu dinyatakan efektif, berdasarkan rata-rata hasil pretest dengan skor 49,2 dan rata-rata hasil posttest dengan skor 84,78. Dapat disimpulkan bahwa augmented reality berorientasi pembelajaran berbasis masalah pada materi IPA layak untuk digunakan.

ABSTRACT

Problems that arise from students' difficulties in participating in the learning process and working on media for a long time make students' abilities low. Student learning outcomes are common because the lack of student knowledge is the main problem in learning. To help improve student learning outcomes can be assisted by using learning media, this study uses augmented reality learning media. This study aims to design problem-based learning based on augmented reality on science material for class V. This research uses a quantitative method. The subjects in this study consisted of 1 media expert, one design expert, and one content expert; three students as individual trials, nine as small group trials, and 23 as field trials. Data collection techniques include qualitative description, quantitative description, and statistical inferential t-test. The results of the study were (1) the design of augmented reality with the ADDIE model stages, (2) the media expert scored 94.4% very good qualification, the design expert test scored 92% very good qualification, the content expert test scored 98.6% qualification very good, individual trials obtained a score of 96.47% very good qualification, group trials obtained a score of 95.57% very good qualifications, (3) based on the effectiveness test it was declared effective, based on the average pretest results with a score of 49.2 and the average posttest results with a score of 84.78. It can be concluded that problem-based learning-oriented augmented reality in science material is feasible.

1. INTRODUCTION

Education is one way to help someone improve their abilities. A good education will greatly influence learning. Education is a means to help humans develop their abilities (Fitri, 2021; Prananda et al., 2020). Learning is the interaction between teachers and students involving facilities and infrastructure. According to previous study learning combines students, books, blackboards, learning tools, facilities, and infrastructure to achieve a learning goal (Tafonao, 2018). The learning process in the classroom determines the success or achievement of learning objectives. Educators must have more open access to existing learning resources (Dewi et al., 2018; Muhaimin, 2020).. Learning is done to fulfill the purpose of education. Knowledge and skills must be well developed. The learning process must be developed to the maximum. The learning process can be maximized by applying science and technology (IPTEK) in the learning process. Science and technology make changes to the learning process for the

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better. This is in line with the opinion state that the development of science and technology has a positive impact by providing convenience in implementing various fields, especially in the field of education (Astuti & Dewi, 2021). Along with the development of science and technology in Indonesia, changes have begun to improve learning as much as possible. But the growing science and technology make students addicted, which causes many students to become negative compared to positive things (Agus, 2020; Astuti & Dewi, 2021). The use of science and technology must be directed to a better path, for example, in science learning. Natural science studies everything that exists in the universe and is related to the life of living things. Based on this statement, the use of technology in science learning is suitable, according to the Ministry of National Education, explaining that the grouping of science is divided into three parts, namely 1) life and health, 2) earth and environment, 3) technology (Cherly Ana Safira et al., 2020; Wibisono et al., 2020). But the use of technology in science learning is still rarely applied and in accordance with the material being taught.

Based on the results of a survey conducted by PISA (Survey Program for International Student Assessment) conducted in 2018, it was shown that the ability scores possessed by Indonesian students in the mathematics, science, and reading assessment were ranked 75th out of 81 countries in the world. Science subjects are one of the subjects that have problems in carrying out the learning process. The problems often encountered in the field are usually the condition of teachers who have not maximized the existing science and technology, causing students to find it difficult to follow science lessons. Science learning should allow participants to learn something from nature (Fitriani Eka et al., 2018; Nida, 2020). Related science education focuses on increasing students' scientific literacy and covers a variety of objectives. Based on the results of questions and answers and observations made together with the homeroom teacher for class V and the teaching teacher in grade fifth. Based on the results of observations, it is known that students carrying out learning experience boredom, then there is a lack of time in making interactive learning media to provoke students' knowledge; there are still subjects that are difficult for fifth-grade students to understand such as mathematics and natural sciences. Other teacher also explained that the media he uses still often uses conventional and PPT lesson media. More clearly, in the learning process in the classroom, there are several problems; namely, students are still having difficulty understanding the material provided due to the transition period from online learning to offline learning. There are many students whose scores are still below the KKM, namely 21 people; students above the National KKM are two people, with the largest score of 79 and the smallest score of 67, and the average student score is 71.02. This indicates that problems occur in the learning process in science lessons (Natural Science).

Problems that are in learning activities must be eliminated so that students can get a good education. Previous study explains the problems in education, which still experience many deficiencies and the low ability of students in Indonesia (Tahmidaten & Krismanto, 2020). Overcoming problems encountered in the learning process can be done in several ways, for example, by using interesting learning media, creating an interactive learning atmosphere, and increasing student learning motivation. Learning media can help the learning process get better (Hasiru et al., 2021; Nurrita, 2018). Many teachers still give students a lot of assignments which causes students to become stressed. Learning media is a tool used to help transfer messages from the sender to the recipient so that they can improve the ability of students until the learning objectives are achieved. Other study explained that learning media are elements that can help improve the quality of students' abilities (Yanto, 2019). The function of learning media according to other study is to foster interest and desire to learn, increase the stimulation of learning activities and can increase the stimulus and psychology of students (Trisiana, 2020). One of the learning media suitable for use in science learning is augmented reality.

Augmented reality is one way to help students understand science learning better. Augmented reality creates 3D holographic images that can be displayed in the real world. Augmented reality consists of several components, such as visualization technology, sensor systems, tracking systems, user interfaces, and processing units (Egger, 2020; Zafar, 2020). Using AR in science learning will help explain abstract material. So, augmented reality is one of the media choices that can be developed to help overcome the problems encountered. Augmented reality will be a medium that presents new experiences for students in the learning process (Petrov, 2020; Sahin & Yilmaz, 2020). Therefore this study aims to design problem-based learning based on augmented reality on science material for fifth grade students.

2. METHOD

The model used in this study uses the ADDIE development model. The use of the ADDIE model in this development research is based on the ADDIE model, which has a systematic aspect in procedural development. The ADDIE model is based on theoretical learning designs suitable for developing learning

media products (Widiarti et al., 2021; Yu, 2020). The ADDIE model has a good system and cannot be randomized; these systematic stages will also make it easier to design a good development model (Tu, 2021). Also, the ADDIE model is easy to apply in designing development models and easy to understand by other researchers and educators. From the goodness provided by the ADDIE model, of course, there are drawbacks given from this model, such as systematic stages that will require work that is long enough to produce the desired product using the ADDIE model. The subjects of this study consisted of experts and students. The experts consisted of 1 instructional design expert, one learning media expert, and one learning content expert. Then the students were divided into three individual and nine small group test students. A field test was carried out on class V to determine the effectiveness of the media. The type of quantitative data used in this development will be explained in more detail. Quantitative data results from questionnaires and tests were carried out to obtain the validity of the augmented reality product being developed. The questionnaire is a data collection technique that provides questions to reviewers from subject content expert trials, instructional design experts, instructional media experts, small group trials, and individual trials. The test method is a data collection technique by conducting a pre-test and post-test to determine the intended target's results.

Augmented reality media will be assessed before being given to students. This assessment was carried out to obtain the feasibility of augmented reality. This feasibility will be tested by subject content experts, learning design experts, learning media experts, small group trials, and individual trials (Burhanudin, 2017). Before assessing the product to be tested for its feasibility, a grid will be developed as a reference for evaluating the feasibility of the product. The learning media expert test was conducted to assess the quality and quantity of the media being developed. The lattice of learning media expert instruments can be seen in Table 1. The learning design expert test was conducted to assess the quality and quantity of the augmented reality designs developed. The lattice of learning design expert instruments can be seen in Table 2. The learning content expert test is carried out to assess the quality and quantity of the material or content used in augmented reality. The lattice of learning content expert instruments can be seen in Table 3. Small group and individual test instruments are used to seek responses from students. The responses from these students will be used to assess augmented reality products. The instrument grids from small group and individual tests can be seen in Table 4.

The next thing to do after preparing the instrument is to test the experts; the experts will assess the augmented reality product being developed to find out whether the product is valid or not. This assessment test uses quantitative description analysis techniques with the questionnaire method and statistical analysis techniques t-test with the test method. Quantitative analysis techniques are data collection techniques in the form of percentages until conclusions are obtained from research (Tegeh & Kirna, 2013). The t-test is used to determine the pretest and post-test comparison. Prior to conducting the t-test, a prerequisite test was carried out to determine the normality and homogeneity of the field test. The reference used to determine decisions using the achievement level of a scale of 5 are presented in Table 5.

After testing the product validity, followed by testing the effectiveness of augmented reality. The effectiveness test was carried out using a pretest and posttest. The pretest and posttest were carried out in class V; the function of this pretest and posttest was to find out whether there was a difference between before using augmented reality and after using augmented reality. After the data is obtained, it will be followed by processing the data using the t-test inferential statistical analysis technique. The following is a grid of pretest and posttest in Table 6.

Table 1. Grid of Learning Media Expert Instruments

No.	Aspect	Indicator	Sub-Indicators	Grain
1	Media Design	a. Media suitability	Media suitability for competency achievement	1
		b. Display design	Color Match	2
			Application layouts	3
			AR Book layouts	4, 5
		c. Text	Text readability	6
			Text layout	7, 8
		d. Image quality	3D image clarity	9
			Image size	10
			speed camera displays the image	11
			Marker drawing design	12
		e. Navigation key	Navigation key display	13
			Navigation button layout	14
			Accessibility navigation buttons	15

No.	Aspect	Indicator	Sub-Indicators	Grain
		f. Explanation of the instructions for use		16
2	Software	a. Smooth operation	Increase the spirit of learning	17
		b. Ease of operation		18, 19
		c. Communicative		20
		d. Interactive		21
3	Benefit	a. AR uses		22
		b. Benefits for students		23
				24
		c. Help the teacher deliver the subject matter	Increase students' understanding	25

Table 2. Grid of Learning Design Expert Instruments

No.	Aspect	Indicator	Question item
1.	Objective	a. Conformity with learning objectives	1
		b. Learning objectives according to the ABCD format	2
		c. Material suitability with AR	3, 4
2.	Strategy	a. Clarity on the use of the strategy used	5
		b. Students can search for information	6, 7
		c. Students can find problems	8
		d. Students can solve problems	9
3	Evaluation	a. Learners can evaluate in learning	10

Table 3. Grid of Learning Content Expert Instruments

No.	Aspect	Indicator	Question Items
1	Learning Design	a. Objective	1
		b. Learning emphasis	2, 3
		c. flexibility	4
		d. AR Book and Application Compatibility	5
		e. Grammar	6
2	Material	a. Content material	7
		b. Material mess	8
		c. Material equipment	9
		d. Evaluation	10, 11
3	Benefit	a. AR introduction	12
		b. Overcome tool limitations	13, 14
		c. Benefits for teachers	15
		d. Benefits for students	16

Table 4. Small Group and Individual Instrument Grids

No.	Aspect	Indicator	Grain
1	Learning Design	a. Conformity of the material with the syllabus	1
		b. Interactive	2
		c. Media flexibility	3
		d. Grammar	4
2	Media View	a. Display design	5
		b. Text	6
		c. Image Quality	7
		d. Navigation key	8
		e. Explanation of the instructions for use	9
3	Software	a. Smooth operation	10
		b. Ease of running AR	11
4	Material	a. Content material	12
		b. Evaluation	13
5	Benefit	a. Overcomes the limitations of practice tools	14

b. Raising the spirit 15

Table 5. Conversion of Achievement Levels with a Scale of 5

Achievement Rate (%)	Qualification	Information
90-100	Very good	No need to revise
75-89	Good	Slightly revised
65-74	Enough	Revised to taste
55-64	Not enough	Many things were revised
0-54	Very less	Repeated product creation

Table 6. Pretest and Posttest Grids

No.	Indicator	Question Items	Cognitive Level
1	Examine the relationship between ecosystem components and food webs	17, 18, 21	C4
2	Linking animals to the ecosystem they occupy	9, 10	C4
3	Comparing all the existing ecosystems in the environment	11, 14	C5
4	Designing food chains in animals	13, 16, 20	C6
5	Identify the types of natural ecosystems	1, 2, 4	C4
6	Assemble the types of animal food based on the ecosystem it occupies	3, 6	C6
7	Selecting living things that live in natural ecosystems	5, 7, 8	C4
8	Summing up living things in an ecosystem	12, 15, 19	C5
9	Analyze food webs of living things	22, 23	C4
Amount		**22**	

3. RESULT AND DISCUSSION

Result

The results of the research will be divided into three parts, namely the design and development of augmented reality, the validity of the results of the development of augmented reality, and the effectiveness of developing augmented reality in natural science material (IPA) in class V. The model used in developing augmented reality is the ADDIE development model. The ADDIE model has systematic sequence stages and has analysis, design, development, implementation, and evaluation stages. The first result will be given in the form of an augmented reality design. The first stage in this design is the analysis stage. The analysis stage aims to determine the needs of students, especially in natural science material. There are several analyzes carried out, such as an analysis of student characteristics, an analysis of learning resources and materials, a curriculum analysis, an analysis of student competencies, and an analysis of learning support facilities. In the analysis of students, the results obtained were that students still had difficulty understanding the material, which caused students' knowledge to be still low, there were still many students whose grades were below the KKM, teachers still rarely used learning media during the learning process, this resulted in a decrease in student learning outcomes. Not only that, there are more student learning outcomes out of 23 students; only two students are above the KKM, and 21 students are below the KKM, with an average of 71.02. Continue the analysis of materials and learning resources. Material and resource analysis was carried out to see the material in class V from theme 1 to theme 5. The material used in the development of augmented reality is ecosystem theme 5. Furthermore, the learning resources used in class V still use a lot of thematic books and several PPTs for the learning process. Then proceed with the analysis of learning facilities. There are learning support facilities such as LCD projectors, Wifi, speakers, laptops, and power sources.

The next stage after the analysis phase is the design stage. At this stage, start designing flowcharts and storyboards. The flowchart is a picture of a systematic process using symbols to compile a program design. The use of flowcharts in the development of augmented reality aims to make the flow of running an augmented reality application flow. The storyboard is an initial design that is used to simplify the process of designing augmented reality in the form of images. The storyboard will be the initial visual display of augmented reality; several scenes describe each display in the storyboard. The next stage is designing and compiling the RPP. Learning Implementation Plan (RPP) is used as a reference in the learning process used by the teacher. The preparation of this lesson plan is adapted to the development of augmented reality to produce systematic lesson plans in the learning process. RPP is composed of learning

steps from the beginning of learning to the completion of learning. After that, proceed with designing objects that will be used in AR. The augmented reality object is a visualization of the storyboard display that has been developed. This object will become a single unit to be developed into an AR display later. AR objects are composed of AR logos and AR buttons. AR backgrounds and others.

The third stage is the developing stage; after all, objects are designed, they will continue to develop augmented reality. Augmented reality was developed using several applications such as Unity 2020, Blender, and Adobe Illustrator as the main applications in designing this augmented reality, as well as several other supporting applications. Furthermore, the display of the augmented reality application that has been developed is shown in Figure 1.

Figure 1. Problem-Based Learning Oriented Augmented Reality in Class V Natural Science Materials

The implementation stage is the stage for implementing spaciousness media. Several experts will implement augmented reality media. Implementations for experts such as learning design experts, learning content experts, and learning content experts. Small group and individual implementation are done for students who have received the developed material. Implementation is carried out for class VI students who have received the material.

The evaluation stage is carried out after implementing the augmented reality media; then, it will be reviewed by the judges. The tests were carried out by learning design experts, learning content experts, and learning content experts. Then proceed to small group and individual tests. The small group test consisted of 9 students, which consisted of 3 students with low scores, three with moderate scores, and three with high scores. Then the individual test was taken by one person, each with low, medium, and high scores. This stage is carried out to determine the feasibility or validity of the developed media. The results of the instructional media expert test scored 94.4% very good qualification, the learning design expert test results scored 92% very good qualification, and the learning content expert test results scored 98.6% very good qualification. Then proceed to students get an individual trial score of 96.47% very good qualification, and small group trials get a score of 95.57% very good qualification.

Based on the results of the effectiveness that has been carried out in field trials to class V. Augmented reality has an important role in the posttest that has been carried out. The initial stage is the pretest for the participants' initial abilities in science lessons. In the pretest stage, students get a score of 49.21. After being given augmented reality media and carrying out the pretest, students scored 84.78. Based on the results of inferential statistical analysis, the sample t-test correlated with dk = 44, T Count = -20.2866, and T Table = -1.68023. So, it can be concluded -1,680<t count<1,680. So H1 is accepted, and H0 is rejected. By accepting H1, there are significant results between before and after the use of augmented reality in natural science material that is oriented toward problem-based learning.

Discussion

Augmented reality is feasible with a problem-based learning model in science learning. This is assessed from the development design using the ADDIE development model. The ADDIE development model is a development model that has a directed systematic, the ADDIE model has effective and systematic guidelines and can support developed learning (Kurnia et al., 2019; Marzal, 2020). Then other study regarding the advantages of using the ADDIE model, such as the ADDIE model being able to adapt well to the chosen development, the flexibility of the ADDIE model can help well so that it is effective to use, and the ADDIE model provides a systematic framework and structure (Kurnia et al., 2019). The ADDIE model is a systematic model for instructional development. The ADDIE model has five stages: Analyze, Design, Development, Implementation, and Evaluation. The ADDIE model is a learning design model that is efficient for learning (Hanafi, 2020; Mie et al., 2018). The ADDIE model is easy to apply in developing types of media, such as augmented reality.

Second, augmented reality is feasible because it has been tested for validity. Testing the validity of problem-based learning-oriented augmented reality was conducted to assess the validity of the media developed to be applied to the field. The validity test is an instrument measurement to produce the accuracy of a study. The validity test is an assessment used to determine the quality of learning media. Several experts carried out the validity test, including learning media experts, learning design experts, learning content experts, students in small group tests, and individual tests (Al Hakim et al., 2021; Jusuf et al., 2022). Previous study uses a validity test to ensure that the media used is valid in research (Blumberg & Fisch, 2013; Octavyanti & Wulandari, 2021). The validity assessment was carried out by experts assisted by using a questionnaire. After going through the tests carried out by the experts, it was continued with a validity test for class VI students at SD N 1 Penglatan. The validity test carried out by students was carried out into individual tests and small group tests. The individual test was conducted with three students with low, medium, and high scores.

Third, the effectiveness test of augmented reality is used to see which media is applied effectively to students. This is in line with the discussion regarding the effectiveness of augmented reality media in influencing the learning process (Whidi Harta et al., 2021). The effectiveness test is an effort to determine the involvement of the learning media being developed. Test the effectiveness of the test method on fifth-grade students of SD N 1 Penglatan. The number of students in class V is 23 students. To see students' knowledge, a pretest was carried out to get scores from students. Then proceed with implementing problem-based learning-oriented augmented reality in class V students. After finishing it, proceed to the posttest to find student scores after using the media. The pretest and posttest results were then processed using a correlated sample T-test.

Using augmented reality in the learning process can help students learn because it can stimulate students' thinking patterns in learning activities and help them understand the material well. This agrees with previous study which state that using augmented learning will stimulate students' thinking skills to think critically about the problems encountered in the learning process (Aditama et al., 2021). Augmented reality also has real objects because it combines real and virtual worlds. Providing real objects to provide an original picture of students because objects are 3D is different from only the application of the lecture method in learning, which makes students interpret objects abstractly. The advantages of augmented reality can be implemented externally and effectively for use in learning (Putra & Suharjana, 2018; Supriono & Rozi, 2018). The application of augmented reality in learning has advantages over other media. Other study explain that using augmented reality can help teachers in the learning process because AR can reconstruct objects to become real (Nistrina, 2021).

The implication of this research is that a problem-based learning approach using augmented reality can increase student involvement and interest in learning natural sciences. The implication is that educators can consider using augmented reality technology as a way to make learning more interesting and relevant for students. This method can be adopted by teachers to help students understand complex concepts through practical and interactive experiences. The limitations of this research in learning require adequate technology infrastructure, including devices such as smartphones or tablets, as well as reliable connectivity. These limitations may affect a successful implementation. In addition, the actual impact of using augmented reality in learning can be challenging and requires a careful evaluation approach.

4. CONCLUSION

The development of problem-based learning-oriented augmented reality on natural science material in class V is suitable for development. Augmented reality positively impacts learning outcomes of natural science class V. Based on the results tested for validity to experts, augmented reality has a valid impact on the learning process. Furthermore, the effectiveness of augmented reality has an impact on when carrying out the pretest and posttest carried out. There is a difference between before and after using augmented reality; this can be seen in the learning outcomes of students. And the students' scores at the time of the posttest exceeded the KKM scores at school, which stated that augmented reality was effective in learning science.

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