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PROBLEM BASED LEARNING MODEL WITH AUGMENTED REALITY MEDIA ENCOURAGES CLASS V SCIENCE LEARNING ACHIEVEMENT

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Abstract
Research on science learning achievement is still not optimal due to the low use of IT media. Apart from that, students are still not used to applying science concepts to everyday life problems. Data collection techniques in this research used pre-test and post-test methods, using multiple choice questions and essays. This research aims to test the impact of the Problem Based Learning model integrated with augmented reality media on the academic performance of class V students. The research carried out utilized quantitative methods with a quasi-experimental design or non-equivalent control group design. The research sample was class V students at Nusukan Elementary School with 28 experimental group students and 28 control group students. The research instrument is in the form of multiple choice questions and essays through validity and reliability tests. The research results show that there is a significant difference between the post-test results for the experimental class, namely 93 and the post-test results for the control class, namely 71. This can be shown from the results of the N-Gain test analysis in the experimental class, which was 85.15% and in the control class, which was 63. .99%. Based on the results of the independent t-test, there are significant differences in the experimental class and control class on student learning achievement. The research results show that augmented reality media is very helpful in the problem orientation step because it is able to encourage students to understand and find solutions to problems or challenges.
Keywords: *Augmented Reality Media; Problem Based Learning Model; Science Learning Achievement*

Abstrak
Penelitian prestasi belajar IPA masih belum optimpal karena rendahnya penggunaan media IT. Selain itu, siswa masih belum terbiasa untuk menerapkan konsep IPA dalam masalah kehidupan sehari-hari. Teknik pengumpulan data dalam penelitian ini menggunakan metode pre-test dan post-test, dengan menggunakan soal pilihan ganda dan essay. Penelitian ini bertujuan untuk menguji dampak model Pembelajaran Berbasis Masalah yang diintegrasikan dengan media augmented reality terhadap kinerja akademik siswa kelas V. Penelitian yang dilakukan memanfaatkan metode kuantitatif dengan desain quasi experimental atau non-equivalent control group design. Sampel penelitian adalah siswa kelas V Sekolah Dasar Nusukan dengan jumlah siswa kelompok eksperimen sebanyak 28 orang dan kelompok kontrol sebanyak 28 orang. Instrumen penelitian berupa soal pilihan ganda dan essay dengan melalui uji validitas dan reliabilitas. Hasil penelitian menunjukkan terdapat perbedaan yang signifikan antara hasil post-test kelas experimen yaitu 93 dan hasil post-test kelas kontrol yaitu 71. Hal ini dapat ditunjukkan dari hasil analisis uji N-Gain pada kelas eksperimen sebesar 85,15 % dan kelas kontrol sebesar 63,99%. Berdasarkan hasil uji t-independen terdapat perbedaan yang signifikan dalam kelas eksperimen dan kelas kontrol terhadap prestasi belajar siswa. Hasil penelitian menunjukkan bahwa media *augmented reality* sangat membantu pada langkah orientasi masalah karena mampu mendorong siswa untuk memahami dan menemukan solusi terhadap masalah atau tantangan.
Kata Kunci: Media Augmented Reality; Model Problem Based Learning; Prestasi Belajar IPA

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Introduction

The 21st century is marked by rapid advancements in science and technology, with technology evolving at an unprecedented pace (Sapira & Ansori, 2024). As such, the skills and knowledge required to meet future challenges in education must be well-prepared (Hidayat et al., 2023). The goal of 21st-century education is to produce high-quality human resources who are capable of processing information accurately and effectively (Amini et al., 2021). In facing the rapid development of the world, the integration of science and technology is very important (Rahayu et al., 2022). Standards for schools in the 21st century or digital era focus on the application of technology in the learning process, both for teachers and students (Pratiwi et al., 2019). Teachers must equip their students for life in the digital age by leveraging their knowledge of subject matter, teaching methods, and technology to enhance student learning experiences. This includes fostering creativity and innovation, both in face to face and virtual learning environments.

Problem Based Learning it was initially introduced by Howard Barrows in 1969 to address issues in the healthcare sector and was subsequently adopted in schools to enhance learning outcomes. Problem Based Learning is a learning model that requires students to be active in understanding a concept through situations and problems presented at the beginning of learning to solve problems. The Problem Based Learning model utilizes real-world problems as a basis for acquiring knowledge and making decisions through the process of problem solving (Fitriyyah & Wulandari, 2019). Problem based learning has a connection between problem solving and creative thinking abilities, as creative thinking is a process employed when generating or developing new ideas that can be achieved by combining various ideas that have been previously applied.

The increasing the utilization of the internet has resulted in rapid progress in learning (Musa & Al Momani, 2022). Learning media serves as a tool to illustrate specific facts, concepts, principles, or processes, making them clearer and more understandable. One of the media that can be used is AR media. AR media is a technology designed to merge and broaden the physical environment or the world of digital users (Arena et al., 2022). The utilization of learning media has a major impact on increasing student motivation, because the media presents material in an innovative and varied way (Firmadani, 2020).

The function of AR media can serve as an interesting alternative technology for elementary school teachers to use interactive multimedia in science learning, enabling experiential learning. Therefore, Augmented Reality presents an exciting technological option for interactive multimedia science learning for elementary school teachers, as it enables students to engage in experiments and experience hands on learning in a dynamic and immersive environment. One of the materials in science education in primary school is the respiratory system. In this material, teachers need media that can describe the human respiratory system by collaborating IT media that can provide a real picture of the respiratory system will make students more interested in understanding the material. Therefore, augmented reality can help learning in areas with inadequate signals and can help teachers make learning more exciting and enjoyable.

Initial observations at Nusukan Elementary School show that the PAKEM learning model is still used by teachers. The learning model that combines the lecture method and group discussions is not effectively integrated. The approach commonly used is more teacher centered, this restriction on student involvement in the learning process results in students often displaying boredom and fatigue during lessons. Interviews with teachers indicate that the use of learning media, especially those incorporating digital technology, is not fully optimized. This is primarily

due to inadequate facilities and infrastructure, as well as teachers' limited skills in utilizing technology based learning tools.

Currently, the academic achievement of Nusukan Elementary School students is still low in science subjects. The daily test results show that only 10 out of 28 students (40%) have achieved the minimum completion standard of 75, with an average score of 70. In contrast, 18 students (60%) have not met the standard, with an average score of 60. These results suggest that nearly half of the students in the class are falling short of the minimum completion standard. According to research by Wanda (2022), there are issues with science learning outcomes due to the lack of the use of learning media. This research aims to address these issues by introducing the Problem Based Learning Model with Augmented Reality media as a solution.

Recent studies by Dinda & Atmojo (2024) emphasize the effectiveness of the problem based learning model in improving student achievement when compared to traditional teaching methods. This finding is further supported by Satila (2022), who demonstrates the success of the PBL model in enhancing student learning outcomes. These studies highlight how PBL engages students in active problem-solving, fostering deeper understanding and critical thinking. By encouraging students to explore real world problems, PBL helps bridge the gap between theory and practice, making learning more relevant and impactful. This approach not only boosts academic performance but also equips students with valuable skills for future challenges. Additionally, research by Nirwana (2024) highlights that the combination of Problem Based Learning and quiziz is more effective in boosting student learning motivation than conventional teaching models. Furthermore, Carolina (2022) indicates that the use of augmented reality can significantly increase student motivation.

In research reviewed by Gaol (2022), it is stated that the use of augmented reality media can enhance students' critical thinking skills. Additionally, research by Zaid (2022) concluded that augmented reality media improved the quality of science learning in elementary schools. Santosa's (2022) study demonstrated an increase in activity and learning outcomes in science education. Furthermore, research by Masrokhah (2021) and Anggraeni & Andriana (2020) shows that there was an improvement in science learning outcomes related to human respiratory organ material, with augmented reality media proving to be effective in enhancing student learning outcomes on the human respiratory system.

Although previous studies provide evidence that the Problem Based Learning model is effective in enhancing student learning outcomes, its application has not yet incorporated technology based media. Further research is necessary to explore how effectively the Problem Based Learning Model can be applied to various learning materials and educational levels. This study aims to examine different teaching methods and strategies for applying Problem Based Learning to student achievement, utilizing diverse technologies. While previous research utilized tools such as quiziz, this study investigates the use of Augmented Reality media. The objective is to examine the effect of the Problem Based Learning model combined with AR media on the learning achievement of grade V students, specifically in the context of human respiratory organs.

Research Methods

This study adopts a quantitative approach with an experimental design, specifically a quasi-experimental or non-equivalent control group design. The comparison between the experimental and control groups serves as the foundation for conducting the quasi-experiment. Additionally, the Problem Based Learning model, combined with Augmented Reality media, is

implemented, and pre-test and post-test instruments are utilized to evaluate student learning achievement.

Primary data obtained came from experimental trials used as data. Fifth grade students of Nusukan Elementary School were used as research samples. The sampling technique involved 28 students from both the experimental and control classes. In the control class, the Problem Based Learning model was applied using picture media, whereas the experimental class utilized the same model with augmented reality media. Data collection in this study employed pre-test and post-test methods, utilizing multiple choice questions and essays as measurement tools to assess learning achievement. These instruments were tested for validity to ensure their accuracy and reliability. The instrument validity test was tested on grade VI students of Nusukan Elementary School. The results of the instrument testing revealed that 12 multiple-choice questions were valid, with a significance value greater than 0.388, while 3 multiple-choice questions were deemed invalid. As a result, the valid instrument test results will be used for the research, and the invalid instruments were removed from the research instrument. After the validity test, the instrument was tested for reliability as shown in Table 1 below.

Table 1. *Reliability Test of Learning Achievement Instruments*

Reliability Statistics	
Cronbach's Alpha	N of Items
.611	15

With an r-table value of 0.388 for the learning achievement instrument, the reliability test results in Table 1 show that the Cronbach's Alpha value is 0.611, which is classified as good.

Several basic requirement tests, including homogeneity and normality tests, were performed to analyze the data. The normality test, using the Shapiro-Wilk test, determined whether the data followed a normal distribution, while the homogeneity test, conducted using the F-test, assessed if the sample was homogeneous. Parametric tests were applied to data that met the normality assumption, while non-parametric tests were used for data that did not follow a normal distribution (Usmadi, 2020). The effect of combining augmented reality media with the Problem Based Learning model was tested through hypothesis testing to evaluate its impact on the learning outcomes of grade V students. The effectiveness of the learning model was assessed using the N-Gain test and t-test, with a significance level set at 0.05. All statistical analyses were carried out using SPSS version 25.

N-Gain evaluation

Calculation of normalized N Gain with the formula according to (Wahab et al., 2018)

$$\text{N-Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}}$$

Criteria :

$g > o,7$	=	High
$0,3 < g < 0,7$	=	Medium
$g < 0,3$	=	Low

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Table 2. *N-Gain Effectiveness Interpretation Categories*

Precentage	Interpretation
< 40	Ineffective
40 – 56	Slightly Effective
56 – 75	Effective Enough
>76	Effective

Result and Discussion

This research took place at Nusukan Elementary School in November 2024. This study aims to assess the effectiveness of the Problem Based Learning model with AR media on student learning achievement in grade V science material. The research utilizes a quasi-experimental design and involves two classes: VC, the experimental class, which implemented the Problem-Based Learning model with AR media, and VB, the control class, which used the PAKEM model with picture media. Both classes consisted of 28 students each. The research was conducted over three meetings. Prior to the treatment, both classes underwent an initial test to assess their baseline abilities. Following the pre-test, the experimental class received the treatment, which involved the application of the Problem-Based Learning model with AR media. While the control class was given the same material using the PAKEM model assisted by pictures. The PAKEM model is a process in which teachers can influence students through a series of certain actions or behaviors aimed at each student who is the target of the influence (Inayah et al., 2023). After all sessions were completed, both classes were given a post-test to measure their ability after treatment.

In the core activities of learning, researchers apply the syntax of the problem-based learning model which consists of 5 syntaxes, namely, (1) Orienting students to the problem, at this stage the teacher encourages students to understand and find solutions to the problems or challenges given. (2) Organizing students to learn, at this stage after students find solutions, the teacher provides explanations related to science learning and the teacher forms students into 7 groups, each group containing 4 people. (3) Guiding individual and group investigations, at this stage the teacher provides a form of problem in the form of LKPD given to each group, then the teacher monitors students if there are students who do not understand how to do the problem and the teacher can explain how or guide so that students are able to do the problem correctly. (4) Developing and presenting work, at this stage the teacher asks students to take turns going to the front of the class to present the results of their group discussions and other groups can provide feedback. (5) Analyzing and evaluating the problem solving process, at this stage the teacher and students make conclusions related to the learning material that has been given, and the teacher provides some evaluation of the results of student work.

The first stage is the introduction which begins with the delivery of apperception, namely linking the material of the respiratory apparatus with the previous material, then given motivation in the form of ice breaking. The second stage is the core starting with group formation followed by being given a problem video that can be accessed by scanning barcodes to hone students' abilities. The next step is to provide a learning video that supports solving the problems contained in the problem video. Furthermore, students try to use IT-based learning media, namely AR media, where students can scan the barcode that has been given and can see real 3D images. After that, students are asked to discuss solving the problem. After the discussion, students are asked to make mind mapping that can be done with the group. In the

final stage is closing, which is summarizing the learning and conducting feedback and follow-up.

After validating the research instruments and confirming their reliability, pre-test and post-test data were collected for analysis. Subsequently, homogeneity and normality tests were conducted for both the experimental and control groups. The results of the data analysis using SPSS are presented below.

Table 3. *Normality Test*

Jenis Tes	Kelas	Significance Value	α
Pre-test	Experiment	0,119	0,05
	Control	0,790	
Post-test	Experiment	0,519	0,05
	Control	0,633	

Based on Table 3. Shows that the normality test results show a significant value of 0.119 and 0.790 for the pre-test of the experimental and control classes. As for the post-test, the significance values are 0.519 and 0.633 for the experimental and control classes. Values greater than 0.05 indicate that the data has a normal distribution.

Table 4. *Homogeneity Test*

	Test of Homogencity of Levene Statistic	df1	df2	Significance Value	α
Based on Mean	O,177	1	54	0,675	0,05

Based on Table 4, the homogeneity test results show a significant value based on mean of 0.675 > 0.05. This indicates that the data is homogeneously distributed.

Table 5. *Independent t-test Pre-test (Experimental Class and Control Class)*

Sig (2-tailed)	α	Nilai-t	Status
0,433	0,05	-0,789	H0 Accepted

Based on Table 5, the Sig (2-tailed) value obtained is 0.433 > 0.05. These results lead to the acceptance of the null hypothesis (H_0) and the rejection of the alternative hypothesis. Therefore, it can be concluded that there is no significant difference in student learning outcomes before the implementation of the Problem Based Learning model with AR media compared to the PAKEM learning model using image media on the topic of human respiratory organs. Following this, an independent t-test will be conducted on the post-test results.

Table 6. *Post-Test Independent t-test (Experimental Class and Control Class)*

Sig (2-tailed)	α	T-Value	Status
0,130	0,05	1,538	H0 Rejected

Based on Table 6, the Sig (2-tailed) value obtained is 0.130 > 0.05. This result leads to the acceptance of the null hypothesis (H_0) and the rejection of the alternative hypothesis (H_1). Therefore, there is no significant difference in student learning outcomes after the implementation of the Problem Based Learning model with AR media, compared to before the application of the PAKEM model with image media on the topic of human respiratory organs.

Table 7. *Dependent t-test Pre-Test and Post-Test Control Class*

Sig (2-tailed)	α	T-Value	Status
0,385	0,05	-883	H0 Accepted

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Based on Table 7, the results of the dependent pre-test and post-test of the control class show a Sig (2 tailed) value of 0.385 <0.05 so that the alternative hypothesis (H_1) is rejected and the null hypothesis (H_0) is accepted.

Table 8. *Dependent t-test Pre-Test and Post-Test Experimental Class*

Sig (2-tailed)	α	T-Value	Status
0,007	0,05	-2.918	H0 Rejected

Based on Table 8, the results of the dependent t-test for the pre-test and post-test of the control class show a Sig (2-tailed) value of 0.007 < 0.05. Therefore, the alternative hypothesis (H_1) is accepted, and the null hypothesis (H_0) is rejected. This indicates that there is a significant difference in student learning achievement before and after the implementation of the problem based learning model with AR media on the topic of human respiratory organs in grade V elementary school. Furthermore, the N-Gain test is used to evaluate the students' learning achievement after applying the Problem Based Learning model with AR media.

Table 9. *N-gain test*

Number of Student	Class	Average Posttest Score	N-Gain (%)	Category
28	Experiment	93,14	85,15%	Effective
	Control	71,75	63,99 %	Effective Enough

Based on Table 9, the N-Gain test of the control class shows a value of 63.99% which indicates in the moderately effective category. Meanwhile, the experimental class managed to achieve an N-Gain test result of 85.15%. Therefore, the problem based learning model with AR media is effective on the learning outcomes of grade V elementary school students.

Learning models are methods applied by teachers to teach students in a particular subject (Marfu'ah et al, 2022). Students need a learning model that can help relate material to everyday life (Kristiana & Radia, 2021). The problem based learning model is learning that is possible when teachers can create an open classroom environment and manage the exchange of student voices (Ifnasari, 2018). Learning media is a teacher's tool to achieve learning objectives (Furoidah, 2020). Augmented reality media is expected to increase the success rate of student learning outcomes through a more interactive learning process (Dewi et al, 2024). Science is very important to be taught in elementary school. The learning process of science really requires the use of learning media. This is due to the abstract nature of science material, so as to adjust to the cognitive capacity of students who are still operational-concrete (Wulandari & Mudinillah, 2022).

Based on the results of research at Nusukan Elementary School, researchers conducted research for 6 times the learning process, namely 3 times learning for the experimental class and 3 times learning for the control class. This research was conducted from November 18-23 2024. Researchers conducted this research using several stages, namely giving questionnaires, pre-test and post-test. The pre-test was given to students with the aim of measuring their initial ability to science material. The experimental class pre-test given to students was carried out before conducting problem-based learning with AR media, while the control class pretest was given to students before the application of the routine learning model. The post-test for the experimental class was given after the application of problem-based learning, while the control class post-test

was given after the application of routine learning. Learning activities in the experimental and control classes started from the introduction, core, and closing activities.

In the core activities of learning, researchers apply the syntax of the problem based learning model which consists of 5 syntaxes, namely, (1) Orienting students to the problem, at this stage the teacher encourages students to understand and find solutions to the problems or challenges given. (2) Organizing students to learn, at this stage after students find solutions, the teacher provides explanations related to science learning and the teacher forms students into 7 groups, each group containing 4 people. (3) Guiding individual and group investigations, at this stage, the teacher provides each group with a problem in the form of a LKPD and monitors the students, offering guidance if any students struggle with solving the problem. The teacher provides explanations to ensure the students understand how to approach the task correctly. (4) Developing and presenting work, in this phase, the teacher asks students to present the results of their group discussions in front of the class, while other groups offer feedback. (5) Analyzing and evaluating the problem solving process, finally, the teacher and students draw conclusions based on the learning material, and the teacher provides evaluations of the students' work results.

In the early stage of learning, students observe learning videos about real problems. Next, in the second stage students are given tasks and they can discuss in their groups to complete the worksheet. They begin to carry out investigations at the guidance stage, both individually and in groups, while the teacher monitors student participation during the investigation process. In the next stage, students present the results of their work. The final stage is closing, namely concluding the learning and providing feedback and follow-up.

Figure 1. Student orientation to the problem

In Figure 1, showing the stage of student orientation to the problem, students are asked to form groups, each group consisting of 4 students. Students are given worksheets to work on projects given by the teacher. In the worksheets there are real life problems that students can work on, students follow the instructions given by the teacher. Therefore, the problem-based learning model is able to actively involve students in learning, thereby generating student learning satisfaction (Rorimpandey, 2022).

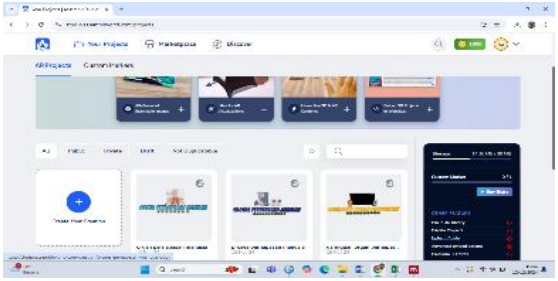

Figure 2. Assemblr Platform
Link https://asblr.com/b681b1

Figure 2 shows the Assemblr platform where students are asked to scan the barcode to see the image/video contained in Assemblr. Augmented reality is a technology that combines two-dimensional and three-dimensional object. With this, students can observe what looks like a real image in front of them even though the image is a three dimensional object.

Figure 3. Use of AR media as material on the human respiratory process

Figure 3 shows the stages of using AR media regarding the human respiratory process. Each group was asked to use AR media to observe images of human respiratory organs. The use of AR media aims to replace learning media that uses PowerPoint so that learning is not boring.

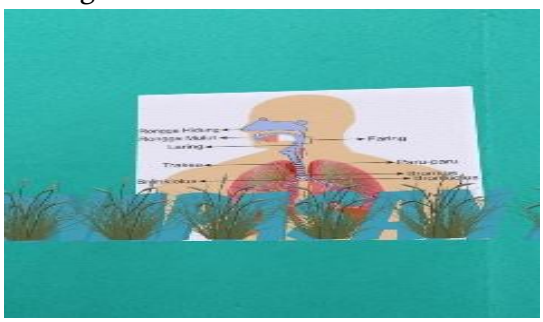

Figure 4. AR media display on smartphone screen

Figure 4 shows the AR media display on a smartphone screen regarding human respiratory organs. Each experimental class group can scan the QR code barcode that has been given by the teacher. AR media can only be used via smartphone by pointing the cellphone camera at an empty wall/room. AR media is like a real/3D image, this can make students more enthusiastic about learning.

All research data indicate that there was no significant difference in student learning achievement before the implementation of the Problem Based Learning model with augmented reality media compared to PAKEM learning using image media. However, after applying the Problem Based Learning model with AR media, significant improvements in student learning outcomes were observed. This demonstrates that the intervention led to positive changes in student performance. The N-Gain test results in the experimental class showed an increase of 85.15% in student learning achievement through the use of the Problem Based Learning model with AR media. In contrast, the control class achieved an N-Gain score of 63.99%, which is categorized as quite effective. Therefore, it can be concluded that the PAKEM model with image media is less effective in improving student outcomes. Based on this description, it can be concluded that teacher learning plays a crucial role in organizing lessons and coordinating various elements that influence students, thus supporting their success. Additionally, according to (Permatasari et al., 2019), the Problem Based Learning model is an innovative, engaging, and challenging approach that helps students build their own knowledge by solving real world problems. Problem learning Problem Based Learning has several advantages, including making

communication between students better and encouraging active learning. Apart from that, PBL can develop students' creative and problem-solving abilities (Dita et al., 2021). The weakness of the Problem Based Learning model is that students fail or lack self confidence, the learning process requires a long time to prepare, and lacks understanding (Yulianti & Gunawan, 2019)

Conclusion

This study was carried out by implementing a problem based learning approach combined with augmented reality media to enhance students' learning outcomes in science subjects. The integration of the Problem Based Learning model with AR media introduces an innovative method, allowing students to engage actively in the learning process through an approach that is novel and has not been previously used. The research results show that Problem Based Learning can help students learn to overcome a problem which will later hone students' abilities. Augmented reality media applied in the Problem Based Learning model is able to help students to be actively involved in the learning process and also makes learning more enjoyable. This can deepen students' understanding of the material which leads to increasing students' abilities.

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