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The Influence of the Problem Based Learning Model on Learning Outcomes of the Properties of Light at SMP Negeri 1 Karanganyar

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ABSTRACT

Problem-based learning (PBL) is an instructional model that utilizes problems as a starting point for acquiring and integrating new knowledge. The purpose of this study was to determine the effect of the Problem-Based Learning (PBL) model on improving students' learning outcomes on the topic of light properties in eighth-grade students at SMP Negeri 1 Karanganyar during the 2022/2023 academic year. This research employed a quasi-experimental approach using a Randomized Control-Group Posttest-Only Design. Data collection methods included the administration of questionnaires, pretests and posttests, and oral interviews. Based on the results of the research, it can be concluded that the Problem-Based Learning model significantly influences students' learning outcomes on the topic of light properties. This is indicated by the t-test results, where tcount = 2.064 and ttable = 2.006 with df = 52. Since tcount > ttable (2.064 > 2.006), the alternative hypothesis (Ha) is accepted, and the null hypothesis (Ho) is rejected. These findings demonstrate that the Problem-Based Learning model has a significant positive effect on students' learning outcomes in the topic of light properties among eighth-grade students at SMP Negeri 1 Karanganyar during the 2022/2023 academic year.

KEYWORDS

Problem based learning,
Learning outcomes,
Natural Science

1. Introduction

Education is an effort to improve the quality of human life. Its goal is to create individuals who are faithful, devoted to God Almighty, knowledgeable, creative, and of noble character and capable of facing the challenges of the 21st century. The development of education plays a crucial role in the progress of a country and therefore requires special attention. In the context of school learning, especially in the subject of Science (IPA), it is essential to implement effective teaching strategies to enhance students' understanding.

Science is a field of study that plays a role in shaping students' scientific thinking by emphasizing the processes of observation, experimentation, and analysis in understanding natural phenomena (Wijayama, 2019). However, in practice, science education is often considered difficult by students, especially because the teaching approach used tends to be conventional. Based on preliminary observations at SMP Negeri 1 Karanganyar, it was found that many students face difficulties in understanding science material, particularly regarding the properties of light.

An interview with one of the science teachers revealed that the average student learning outcome at SMP Negeri 1 Karanganyar is still low, at 63, while the minimum completeness criterion (KKM) set is 77. This indicates a gap in concept comprehension that needs to be addressed through more innovative teaching strategies. One of the reasons for the low student performance is the use of teacher-centered learning methods, where the teacher is the main source of information, and students tend to be passive in receiving the material. This situation limits the interaction of students with the learning material, making it difficult for them to understand concepts in depth.

To address this issue, a more interactive and student-centered teaching model is needed. One approach that can be used is Problem-Based Learning (PBL). PBL is a teaching model that uses problems as the starting point of learning, where students are encouraged to analyze and find solutions to the given problems (Cahyo, 2013; Wulansari, Hanik & Nugroho, 2019). This model emphasizes learning based on real-world problems, which can enhance conceptual understanding and students' critical thinking skills (Sutrisna & Sasmita, 2022). In addition, PBL has been proven effective in increasing student engagement in the learning process. PBL allows students to develop higher-order thinking skills, such as analyzing, evaluating, and creating solutions to real-world problems (Tanna, et al, 2022; Mansur, et al. 2012). This is in line with research conducted which shows that PBL helps students build deeper conceptual understanding than conventional methods (Yew & Goh, 2016; Hmelo-Silver, 2004).

According to Sanjaya (2016), PBL has several advantages, including increasing students' motivation and learning activities, helping students link theory to real-world problems, and developing critical thinking abilities and interpersonal skills in group work. Previous studies have shown that the implementation of the PBL model significantly improves student learning outcomes compared to conventional teaching methods (Bella & Bachri, 2020; Insani et al., 2018). In addition, a study conducted by showed that the implementation of PBL not only improves learning outcomes but also improves students' communication and collaboration skills in completing problem-based tasks (Ulfa & Rosidin, 2024; Saldo & Walag, 2020; Putri, et al. 2023). Thus, the implementation of the PBL model in science learning, especially the material on the properties of light, is expected to have a positive impact on students' conceptual understanding and improve their learning outcomes.

Based on the background above, this study aims to analyze the impact of the Problem-Based Learning model on science learning outcomes related to the properties of light in class VIII at SMP Negeri 1 Karanganyar. This study is significant as no previous research has specifically investigated the effectiveness of the PBL model in teaching the properties of light at this school. Therefore, this research is expected to contribute to improving the quality of science education through the implementation of the PBL model.

2. Method

This study uses a quantitative research approach. Quantitative research is a methodology based on the philosophy of positivism, typically used for research involving specific populations or samples to test predetermined hypotheses (Sugiyono, 2017). The research method applied is a quasi-experimental design. Experimental research aims to determine whether or not a cause-and-effect relationship exists between an intervention and the subjects under investigation. In other words, experimental research seeks to establish whether an action produces certain outcomes (Arikunto, 2019).

In this study, the researcher compares two groups subjected to different treatments: one group using the Problem-Based Learning (PBL) model and the other using conventional methods. The goal is to examine the differences in student learning outcomes following the treatments. The research design used is outlined in the table 1.

Table 1. Research design

Group	*Pre Test*	*Treatment*	*Post Test*
Experiment	Q 1	X	Q 2
Control	Q 1	Y	Q 2

Information :
X : Learning in class experiment with using *the Problem Based Learning* model
Y : Learning in class control with using conventional models
Q1 : Class Pre Test Results Experiment and Control
Q2 : Class Post Test Results Experiment and Control

The population in this study consists of all the eighth-grade students of SMP Negeri 1 Karanganyar for the academic year 2022/2023, totaling five classes. The sample was selected from this population using the cluster sampling technique. This sampling method involved selecting two classes to represent the sample. Class VIII-A was selected as the experimental group, and Class VIII-B as the control group.

For data collection, several tests were conducted, including 1) validity test: To ensure the accuracy of the measurement instruments, 2) reliability test: To check the consistency of the instruments, 3) normality test: To assess if the data follows a normal distribution, 4) homogeneity test: To verify the similarity of variances between groups, 5) t-test: to compare the learning outcomes between the experimental and control groups.

3. Results and Discussion

3.1 Instrument Test

Validity test done with use correlation *Pearson Correlation.* Criteria in determine valid or or not with method compare r table and r count as well as compare Sig. (2-tailed). Criteria r count > r table That is said to be valid, while the Sig. (2-tailed) < 0.05. Researcher conducted trials in class VIII C of SMP Negeri 1 Karanganyar year lessons 2022/2023 with amount respondents were 20 students . Analysis results validity item question is as following (Table 1).

Table.1. Validity Test Results

1	0.766	0.423	Valid
2	0.807		
3	0.695		
4	0.770		
5	0.690		
6	0.708		
7	0.672		
8	0.617		
9	0.685		
10	0.727		

Based on table on can known that all over item question declared valid, so can used as tool data collection in research This. Reliability test used researcher in do study This use analysis *Cronbach's Alpha.* Following results of reliability tests in research (Table 2).

Table.2. Reliability test results

Cronbach's Alpha	***N of Items***
,885	10

Based on table on can known that mark *Cronbach's Alpha* is 0.885 or more big of 0.60 so that the research instrument stated reliable. The normality test in this study used the *Kolmogorov-Smirnov test (Explore Analysis)* to determine whether the data distribution for each variable was normal or not. With criteria measurement as following 1) Decision making: If the probability is > 0.05, then the data is normally distributed, 2) If the probability <0.05, then the data is not normally distributed. Following is normality test results in research (Table 3).

Table.3. Normality Test Results

Characteristics	***Class***		***Results***	***Interpretation***
	Control	***Experiment***		
Asymp.sig (2 tailed)	0.096	0.060	probability > 0.05	Normally distributed

Based on table above , it is known that mark significance *Asymp.sig (2 tailed)* of 0.096 for class control and 0.60 for class experiment . So it's appropriate with basic taking decision in the normality test

kolmogorov-smirnov above , yes concluded that the data is normally distributed .Data homogeneity test was carried out For know whether data group has the same variance or No with perform the Levene's Test. As for the basics collection decision in the homogeneity test is a) If value significance > 0.05, then said that variant of two data or more data group is the same, b) If value significance < 0.05, then said that variant of two data or more group population no the same. Following is homogeneity test results in the research (Table 4).

Table 4. Homogeneity test results

Characteristics	Class		Results	Interpretation
	Control	Experiment		
Significance		0.386	significance > 0.05	Homogeneous

Based on the output above , it is known sig value . Levene's test for equality of variances for variable results Study is 0.386. Because the sig value . 0.386 > 0.05, then can concluded that variance of result data learn from students class control and class experiment is homogeneous.

Ability Test beginning used For know There is or not difference ability initial belonging to the group control and group experiment . Ability different starting points for the groups control and group experiment can become threat big for Internal validity of research . Therefore that's one the solution that is with test results *pretest* second group . Following ability test results early in the research(Tbale 5).

Table.5. Ability test results beginning

Characteristics	Class		Results	Interpretation
	Control	Experiment		
Significance		0.068	significance > 0.05	Homogeneous

Based on the output above , it is known sig valu . Levene's test for equality of variances for variable results Study is 0.068. Because the sig value. 0.068 > 0.05, then can concluded that variance of result data learn from students class control and class experiment is homogeneous.

Known that the data is normally distributed and homogeneous, then For test the data obtained use t-test formula with level significant $\alpha = 0.05$. The t test (t-test) performs testing to coefficient regression in a way partial , testing This done For know significance role in a way partial between variable independent to variable dependent with assume that variable other independents are considered constant. Criteria t-test hypothesis for analyze data in study is as following a) If t- count < t- table , then Ho is accepted and not there is The significant influence of *problem based learning model learning* on the learning outcomes of the properties of light in class VIII students at SMP Negeri 1 Karanganyar for the 2022/2023 academic year, b) If t -count > t- table, then Ho is rejected and exists The significant influence of *problem based learning model learning* on the learning outcomes of the properties of light in class VIII students at SMP Negeri 1 Karanganyar for the 2022/2023 academic year. Following is results of hypothesis testing (t test) in research (Table 6).

Table 6. T test results

Characteristics	Results		Conclusion
	Class experiment	Class control	
t_{count}	2,064		Ho was rejected
t_{table}	2,006		

The calculation results show that the t-count is 2.064, while the t-table is 2.006 with a degree of freedom (df) of 52. Since t-count > t-table, this indicates that the alternative hypothesis (Ha) is accepted, and the null hypothesis (Ho) is rejected. This means that there is a significant influence of the Problem-Based Learning (PBL) model on the learning outcomes of the properties of light among class VIII students at SMP Negeri 1 Karanganyar for the 2022/2023 academic year.

The study aimed to investigate the influence of the PBL model on the learning outcomes of the properties of light among class VIII students at SMP Negeri 1 Karanganyar in the 2022/2023 academic year. The total number of students in the study was 54, with 22 students in class VIIIA (experimental group) and 32 students in class VIIID (control group). Using the cluster sampling technique, the researcher selected class VIIIA as the experimental group and class VIIID as the control group.

To develop valid instruments, a trial was conducted in class VIIIB with 20 students, resulting in 10 valid items. The calculation results showed a t-count of 2.064, while the t-table value was 2.006 with df 52. Since t-count > t-table, the alternative hypothesis (Ha) is accepted, and the null hypothesis (Ho) is rejected. This confirms that there is a significant influence of the PBL model on students' learning outcomes regarding the properties of light in class VIII students at SMP Negeri 1 Karanganyar in the 2022/2023 academic year.

Based on the results, the average post-test score for the experimental group was 87.54 (with 22 respondents), while the control group had an average score of 83.75 (with 32 respondents). The research findings indicate that the learning outcomes related to the properties of light using the PBL model were significantly higher than those of the control group, which used teacher-centered methods. Teacher-Centered Learning (TCL) is a traditional model where the teacher is the primary source of information, and the classroom environment is structured and controlled (Arends, 2013; Agrahari, 2016; Woods & Copur-Gencturk, 2024).

These results support previous research conducted by Sutrisna and Sasmita (2022), which showed that students in the experimental group using the PBL model had higher average learning outcomes than the control group, which used direct learning methods. In their study, the experimental group had a mean score of 79.94, while the control group had a mean score of 70.82. This suggests that the PBL model has a positive impact on students' learning outcomes in science. Similarly, Robiyanto (2021) found that PBL could significantly increase students' learning outcomes, with scores improving from 57.14 before the intervention to 79.09 after the intervention.

Furthermore, Handayani (2016) also concluded that there was a significant difference in science learning outcomes between students in the PBL group and those in the non-PBL group. The study showed that the significance value was 0.005, which is less than the critical value of 0.05, leading to the rejection of the null hypothesis (H0) and the acceptance of the alternative hypothesis (Ha).

The advantages of the PBL model include its ability to enhance student understanding by presenting real-world challenges that require active problem-solving. PBL fosters critical thinking and provides students with opportunities to apply knowledge in real-life contexts. It also encourages greater student engagement and satisfaction by making learning more dynamic and interactive (Sanjaya, 2016; Effendi & Hendriyani, 2019; Li, et al. 2018).

In the experimental group, students actively engaged in the learning process and were challenged by the problems posed by the teacher. They were motivated to solve the problems and maximized their efforts to succeed. This approach develops students' critical thinking skills and provides opportunities for them to apply their knowledge in real-world situations.

In contrast, in the control group with teacher-centered methods, learning was primarily lecture-based, with students taking notes and answering factual questions. Although some students were able to answer questions about the properties of light, others struggled, and a few did not complete their assignments. Some students also engaged in off-task activities, such as chatting with friends or playing, rather than focusing on the lesson.

Based on the above discussion, it can be concluded that the Problem-Based Learning (PBL) model had a greater impact on improving students' learning outcomes in the properties of light compared to the teacher-centered model at SMP Negeri 1 Karanganyar in the 2022/2023 academic year.

4. Conclusion

Based on results research and discussions that have been carried out done so can concluded that learning model problem-based learning influential to results study students on the material characteristic

light. This matter indicated by the value results tcount = 2.064 whereas ttable = 2.006 with df 52. With so known that tcount > ttable namely 2.064>2.006 which means Ha is accepted and Ho is rejected. With matter the show that there is influence significant problem based learning model to results study characteristic light on participants educate class VIII of SMP Negeri 1 Karanganyar Academic Year 2022/2023.

Based on the research findings, several suggestions can be made. Teachers should select appropriate teaching methods that actively engage students in the learning process, such as the Problem-Based Learning (PBL) model, which enhances critical thinking and problem-solving skills. Schools should support effective learning by providing necessary resources, teacher training, and policies that promote innovative teaching strategies. Future researchers are encouraged to explore similar studies on different topics to gain a broader understanding of the effectiveness of PBL in various subjects and educational contexts.

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