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The Effectiveness of PBL and PjBL Models on Students' Science Learning Outcomes in Material Properties of Elementary School Students

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Abstract: The purpose of this study was to analyze the average of students' science learning outcomes for the material properties of light in the application of Problem Based Learning (PBL) model with direct learning at fifth grade students at elementary school in Mlonggo Jepara District. The results of this study are: 1) The average of students' science learning outcomes for the material properties of light in the application of PBL model are better than direct learning in fifth grade students at elementary school in Mlonggo Jepara District based on the description of the data there is a difference in the average score of pre-test and post-test in PBL class. This is based on the results of the analysis of the average pre-test and post-test score in PjBL class and control class. After the test, there is a difference in the average score. 3) The average of students' science learning outcomes for the material properties of light in the application of Problem Based Learning (PBL) model are better than Project Based Learning (PjBL) model. This is based on the results of the N-Gain test proving that the PBL and PjBL models are quite effective in improving science learning outcomes in the material properties of light. A higher increase occurred in the experimental class that using Problem Based Learning (PBL) model. It can be concluded that Problem Based Learning model is more effective to increase students' science learning outcomes at fifth grade students of elementary school in Mlonggo Jepara District.

Keywords: Knowledge, learning chemistry, intervention program, process skills, science education

1. Introduction

Based on the results of the researcher's interview with the fifth-grade teacher at SD Negeri 1 Karanggondang, Mlonggo Jepara District, the science learning outcomes on the material properties of light for the 2022/2023 academic year out of 21 students were only 18.2% or 4 people who scored above the standard of minimum completeness (KKM) and 81,8% of other students have not fulfilled the KKM. This is because learning is only centered on the teacher which is called conventional learning. The teacher should have carried out learning that aroused interest in learning and student character with innovative and creative learning models such as Problem Based Learning model and Project Based Learning model.

Based on the results of previous research by Nurmawati et al. (2022) entitled Analysis of the Application of Project Based Learning and Problem Based Learning Models for Elementary School Students shows that the similarities in Project Based Learning (PjBL) and Problem Based Learning (PBL) models are both innovative learning models where learning is student-centered. Anazifa and Djukri (2017), analyze the effect of Problem Based Learning and Project Based Learning Models on students' social sensitivity and verbal activities. The results showed that there was an influence of the Problem Based Learning and Project Based Learning models on students' verbal activities, and there was an influence of the Problem Based Learning and Project Based Learning models on the social sensitivity of fourth grade elementary school students in Cluster Karang Kusuma Mranggen Demak.

Masriah et al. (2021) study showed that there is an influence of the application of problem-based learning and discovery learning models on improving the mathematics learning outcomes of class IV students. Handika et al. (2021), the research aimed to analyzing the effect of project-based learning and problem-based learning models to improve student learning outcomes in Class V. The result showed that the application of the Project Based Learning and problem based learning models has an effect on the learning outcomes of fifth grade students.

This was also reinforced with research by Devi et al. (2020), the research aimed to describe the improvement of critical thinking skills using the problem-solving model aided by thematic comic media in class IV SD 1 Japan. The results showed that the critical thinking skills of class IV students at SD 1 Japan, Mejobo District. Kudus can be achieved through learning through Problem Solving assisted by thematic comic media.

The Problem Based Learning (PBL) learning model is a learning model that involves student activities and creativity in learning. PBL focuses on problem solving, in solving problems, students are encouraged to be active, so that knowledge does not only come from the teacher, but students are encouraged to construct their own new knowledge based on previous knowledge or information (Sueni, 2019). Project Based Learning (PjBL) is a teaching approach that is built on real learning activities and tasks that provide challenges for students related to everyday life to be solved in groups. Project Based Learning is an innovative learning model that is student centered and places the teacher as a motivator and facilitator where students are given the opportunity to create a project based on what they have learned according to the creativity of each student. The application of the PjBL model has the potential to meet learning demands (Irfana et al., 2022; Kokotsaki et al., 2016; DeFillippi, 2001).

Science education has a role in realizing the Pancasila Student Profile as an ideal depiction of the profile of Indonesian students. The Pancasila Student Profile was formulated through literature studies and focused discussions involving experts in the fields of Pancasila, inter-religious relations, educational policy, educational and developmental psychology, as well as educational stakeholders. Based on this study, the Pancasila Student Profile was formulated in one comprehensive statement, namely Indonesian students are lifelong learners who are competent and have character according to Pancasila values (Hartati et al., 2024; Imania et al., 2022; Muhardini et al., 2021). Learning outcomes are the abilities possessed by students after students receive their learning experience. Learning outcomes are the potentials (mental and physical) that are formed in students, the result of the education and teaching process. Learning outcomes can be interpreted as the level of student success in studying subject matter expressed in the form of test results (Irawati et al., 2021; Sadler & Dawson, 2012).

This study was conducted to analyze 1) the average of students' science learning outcomes for the material properties of light in the application of Problem Based Learning (PBL) model with direct learning at fifth grade students of elementary school in Mlonggo Jepara District. 2) the average of students' science learning outcomes for the material properties of light in the application of Project Based Learning (PjBL) model with direct learning at fifth grade students of elementary school in Mlonggo Jepara District. 3) the average of students' science learning outcomes for the material properties of light in the application of Problem Based Learning (PBL) model with Project Based Learning (PjBL) model at fifth grade students of elementary school in Mlonggo Jepara District.

2. Methodology

This study used quantitative research with a quasi-experimental design method, namely this design had a control group, but could not fully function to control external variables that affect the implementation of the experiment. This research had two groups where the first group is called the experimental group, namely students will receive treatment using the Problem Based Learning (PBL) and Project Base Learning models, while the second group is called the control group using direct learning method. Quasi-experimental design used was a type of non-equivalent control group design. In this design, there were pretest and posttest for the experimental and control groups.

Table 1. Non-Equivalent control group design

Class	Pretest	Treatment	Post test
Experiment	O_1	X_1	O_2
Control	O_1	X_2	O_2

(Source: Sugiyono, 2019)

The population frame of the study was the Elementary School students in Mlonggo District, Jepara Regency. This study used simple random sampling technique. The sample of this study was 64 students, where from grade five of SD Negeri 3 Srobyong with a total of 27 students and grade five of SD Negeri 1 Karanggondang with a total of 21 students as the experimental class. Meanwhile, the control class is from SD Negeri 8 Suwawal with a total of 15 students. To conduct the study, permission was approved by the division superintendent and high school principals.

This study used two types of instruments, namely learning tools and data collection instruments. Learning tools used in research are: learning outcomes, learning objectives flow, teaching modules, and student activity sheets. Meanwhile the research instrument used was a test, which consisted of pre-test and post-test. Pre-test were used to measure students' understanding before being treated, while Post-test were used to measure students' understanding after being given treatment. The tests given during the Pre-test and Post-test are in the form of multiple-choice tests made based on basic competencies and indicators.

Data analysis techniques used were descriptive data analysis techniques and quantitative analysis technique. Descriptive analysis techniques consist of prerequisite tests in the form of normality test, homogeneity test, and hypothesis test using different tests or t-tests. Meanwhile, quantitative analysis technique was used to analyse the results

of the pre-test and post-test of students' science learning outcomes through the Problem Based Learning and Project Based Learning models. Data from the test results were analysed quantitatively using SPSS software and Microsoft Excel 2013.

3.   Results and Discussion

The research findings described by the researcher contain the findings obtained during and after the research was carried out. The research findings data discussed come from the results of the pretest and posttest data analysis using the SPSS version 23. Explanation of the analysis of the findings includes: 1) testing the effect of applying the Problem Based Learning model on the science learning outcomes of material on the properties of light; 2) testing the effect of implementing the Project Based Learning model on the results of the science and technology material on the properties of light; and 3) testing the effect of differences in science and science learning outcomes regarding the properties of light for class V elementary school students whose learning process applies the Problem Based Learning and Project Based Learning models. Pretest data is research data provided by researchers before taking action in experimental research. Based on the Table 2, it shows that the mean score of control class was 33.33. The mean score of PBL (Problem Based Learning) class was 52.59 and the PjBL (Project Based Learning) class was 31.90. The highest pre-test score for the control group was 60, meanwhile for the PBL group was 70 and for the PjBL group was 50.

Table 2. Result of pre-test data analysis

Statistics			
	Pre-test Control	**Pre-test PBL**	**Pre-test PjBL**
N Valid	15	27	21
Mean	33.33	52.59	31.90
Median	30.00	50.00	30.00
Mode	30	60	40
Std. Deviation	14.960	12.888	13.645
Variance	223.810	166.097	186.190
Range	50	40	40
Minimum	10	30	10
Maximum	60	70	50
Sum	500	1420	670

Post-test data is data provided by researchers after treatment has been carried out in the experimental and control classes. Based on Table 3, it showed that the mean score of the control class was 50 while the PBL class is 81.85 and the PjBL class is 70. There was a significant difference in the mean score of control class and the PBL and PjBL experimental the KKM 65, so the control class had an average below the KKM and the experimental class 1 and 2 had the mean score above the KKM.

Table 3. Result of pre-test data analysis

Statistics			
	Post test Control	**Post test PBL**	**Post test PjBL**
N Valid	15	27	21
Mean	50.00	81.85	70.00
Std. Error of Mean	3.780	2.562	2.582
Median	50.00	90.00	70.00
Mode	30[a]	90	70
Std. Deviation	14.639	13.312	11.832
Variance	214.286	177.208	140.000
Range	40	40	40
Minimum	30	60	50
Maximum	70	100	90
Sum	750	2210	1470

The t-test was used to test the hypothesis. The hypothesis is formulated in the form of a statistical hypothesis. Hypothesis 1, namely the Problem Based Learning (PBL) model for science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District is better than the direct learning model. The proposed hypothesis is:

H0: The Problem Based Learning (PBL) model for science learning outcomes at fifth grade students of elementary School Mlonggo Jepara District is no better than the direct learning model.

Ha: The Problem Based Learning (PBL) learning model for science learning outcomes in fifth grade students of SD Mlonggo Jepara District is better than the direct learning model.

Based on the hypothesis t-test in Table 4 showed that the mean score of the PBL class is 81.85 while the control class is 50. The t test is 7.172 while t table with df = 40 is 2.423, so t test > t table where 7.172 > 2.423 so the null hypothesis (H0) is rejected, and alternative hypothesis (Ha) is accepted. It can be concluded that there are differences in the learning outcomes of fifth grade students regarding the properties of light using the PBL model with direct learning.

Table 4. Result of t-test hypothesis 1

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
Learning outcomes	Post test PBL	27	81.85	13.312	2.562
	Post test control	15	50.00	14.639	3.780

Hypothesis 2, namely the Project Based Learning (PjBL) model for science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District is better than the direct learning model. The proposed hypothesis is:

H0: The Project Based Learning (PjBL) model for science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District is no better than the direct learning model.

Ha: The Project Based Learning (PjBL) model for science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District is better than the direct learning model.

Based on Table 5, the t test for hypothesis 2 indicates the average value of the PjBL class is 70.00 and the control class is 50.00. While t test is 4.530 while t table with df = 34 is 2.441, it meant that t test > t table where 4.530 > 3.348. it can be concluded that the null hypothesis (H0) is rejected, and the alternative hypothesis (Ha) is accepted. There are differences in the learning outcomes of fifth grade students regarding the properties of light using the PjBL model with direct learning.

Table 5. Result of t-test hypothesis 2

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
Learning outcomes	Post test PjBL	21	70.00	11.832	2.582
	Post test control	15	50.00	14.639	3.780

Hypothesis 3, namely the Problem Based Learning (PBL) model for science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District is better than the Project Based Learning (PjBL) model. The proposed hypothesis is:

H0: The Problem Based Learning (PBL) model for science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District is no better than the Project Based Learning (PjBL) model.

Ha: The Problem Based Learning (PBL) model for science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District is better than the Project Based Learning (PjBL) model.

Based on the hypothesis t test in Table 6 showed the mean score of the PBL class is 81.85 while the PjBL class is 70.00. It could be seen that t test is 3.210 while t table with df = 46 is 2.410, so t test > t table where 3.210 > 2.410 so H0 is rejected, and Ha is accepted. In conclusion, there are differences in the learning outcomes of fifth grade students regarding the properties of light using the PBL model with PjBL model.

Table 6. Result of t-test hypothesis 3

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
Learning outcomes	Post test PBL	27	81.85	13.312	2.562
	Post test PjBL	21	70.00	11.832	2.582

N-gain test is used to see that students' learning outcome is increase or not. This test was done to all group class. The result of N-Gain test could be seen in Table 7. Based on Table 7, it can be seen that the result of N-Gain test of control class is 25.4550. It means that the direct learning method is not effective because it includes in range g < 40. It can be concluded that the direct learning method is not effective to increase students' science learning outcome in material properties of light at fifth grade students of Elementary School in Mlonggo Jepara District. The result of N-Gain test of PBL class is 63.095. It means that the use of Problem Based Learning model is effective because it includes in range 56 – 75. It can be concluded that Problem Based Learning Model is effective to increase students' science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District. Meanwhile, the result of N-Gain test of PjBL Class is 56.1772. It means that the use of Project. Based Learning Model is effective because it includes in range 56-75. It can be concluded that Project Based Learning model is effective to increase students' science learning outcomes at fifth grade students of Elementary School in Mlonggo Jepara District.

Table 7. Result of N-gain test

Descriptives				Statistic	Std. Error
Class				**Statistic**	**Std. Error**
N-Gain (%)	Control	Mean		25.4550	3.12075
		95% Confidence Interval for Mean	Lower Bound	18.7617	
			Upper Bound	32.1484	
	PBL	Mean		63.0952	4.78290
		95% Confidence Interval for Mean	Lower Bound	53.2638	
			Upper Bound	72.9266	
	PjBL	Mean		56.1772	3.18930
		95% Confidence Interval for Mean	Lower Bound	49.5245	
			Upper Bound	62.8300	

The results of this research are in line with Masriah et al. (2021) found that there is an influence of the application of problem-based learning and discovery learning models on improving the mathematics learning outcomes of class IV students. Other research that was also in line was research by Handika et al. (2021) showed that the application of the Project Based Learning and problem-based learning models has an effect on the learning outcomes of fifth grade students. This was also reinforced with research by Devi et al. (2020) showed that the critical thinking skills of class IV students at SD 1 Japan, Mejobo District. Kudus can be achieved through learning through Problem Solving assisted by thematic comic media.

4.   Conclusion

Based on the result of test of hypothesis 1 until 3 and N-Gain test also based on the results of relevant studies, the Problem Based Learning (PBL) and Project Based Learning (PjBL) models are effective for improving science learning outcomes at fifth grade students at Elementary School in Mlonggo Jepara District. Because of that, hypothesis 3 which states that the Problem Based Learning (PBL) model for science learning outcomes in fifth grade students of SD Mlonggo Jepara District is better than the Project Based Learning (PjBL) model is proven.

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Conflict of Interest

The authors declare no conflicts of interest

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