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The Effect of Problem Based Learning Models on Interpersonal Intelligence and Student Learning Outcomes in Science Subjects

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Abstract: Interpersonal intelligence is important for achieving learning goals and learning outcomes are the output of the teaching and learning process. This research aimed to examine the impact of the problem-based learning paradigm on students' achievement in science classes and their development of social skills. The participants in this study were fifth graders. 45 pupils were selected at random using a cluster sampling technique methods of information collection that make use of examinations and polls. Quantitative descriptions were used in the data analyses. The significance value (2-tailed) for the study's findings regarding interpersonal IQ, based on the independent sample t-test, was 0.005 < 0.05. The (2-tailed) significance level of the learning outcomes is 0.000 < 0.05. This shows that Ho is refuted and Ha is accepted in terms of the criteria used to make judgments while testing a hypothesis. In order to increase interpersonal intelligence and student learning outcomes, problem-based learning approaches are used.

Keywords: Interpersonal Intelligence; Learning Outcomes; Problem Based Learning; Science

Introduction

A person can develop, assess, and modify what is taught through education (Letiche et al., 2023). The improvement of intelligence and learning outcomes is one of education's objectives. According to (Sidqi Salsabilla, 2019), intelligence is a place for our skill to grow so that there is scientific feedback that will allow us to take realistic activities and have goals and notions of practical and rational thinking. On the other hand, learning outcomes are modifications in behavior brought about by the learning process, including changes from ignorance to knowledge and from ignorance to comprehension (Amri et al., 2022).

Interpersonal intelligence one of several varieties of intelligence. According to (Sholihatunnisa, 2019), interpersonal intelligence is the capacity to comprehend and value people in order to establish, foster, and maintain social connections in ways that benefit all parties. Because it has a significant impact on a person's capacity for adaptation, empathy, and social relationships as well as their ability to successfully communicate and assume leadership roles, interpersonal intelligence is crucial (Sidqi Salsabilla, 2019; Vaquero-Solís et al., 2020). Students development of different types of intelligence can be accelerated by teachers who use pedagogical tasks in the classroom that activate all forms of intellect. In order to maximize their capabilities and prospects, this treatment aids students in understanding themselves and their potential (Ghaznavi et al., 2021). According to Astari et al., (2018), learning experiences are characterized by the creation of new abilities in pupils, which results in learning outcomes. Key learning outcomes are used to gauge how much change students have undergone following their learning experience. Students' knowledge, attitudes, and skills can be used to observe and measure these changes (Djamaluddin & Wardana, 2019)

The findings of a study on fifth-grade elementary school by (Manuaba et al., 2020) On fifth-grade elementary school kids, it was discovered that there was

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a lack of empathy, low interpersonal intelligence, and some students who did not actively participate in working on group tasks or who did not turn in their assignments on time. Understanding interpersonal intelligence is crucial since it will influence learning and student learning outcomes. The findings of research by (Bella, 2019; Wardani, 2018) point to low learning outcomes, because the instructor did not employ an effective strategy for teaching science, especially when studying material that was difficult for students to understand. Discussion activities also suffered because not all students participated actively, according to Bella and Wardani's research. In particular for science content, issues with science learning will surely effect how well students comprehend the subject being studied and their learning outcomes (Febriyanti & Mayarni, 2022; Husnidar & Hayati, 2021).

There are various approaches to enhance student learning results and interpersonal intelligence. To choose what kind of learning model will be utilized to promote interpersonal intelligence and science learning objectives, teachers must be able to assess how interpersonal intelligence is developing and student learning outcomes. When teaching strategies fit the needs and preferences of the pupils, they are more likely to be successful. This form of instruction is used since each student interprets and reacts to learning in a unique way (Solomon, 2020). Because the Problem-Based Learning paradigm is so well suited to lessons in the natural sciences, it is employed as a solution to problems with science learning. After all, the environment that kids are exposed to has a strong correlation with natural events. Natural events are employed as both genuine challenges and the foundation for learning in this model (Bella, 2019).

According to the problem-based learning approach, learning activities are first accompanied by issues that are connected to real-world activities. Students are then instructed to select problem-solving tasks (Nurhaedah et al., 2022). The problem-based learning paradigm is an essential one that can aid students in developing their critical thinking, creativity, problem-solving, innovation, and systematic thinking abilities, among other abilities (Faqiroh, 2020). The instructor will facilitate and promote discussion, inspiring the class to assess each other's development. Teachers will work with students to assist them connect their growing knowledge to new ideas and dispel misconceptions about pertinent laws and how to use them to solve problems (Houghton, 2023; Mayarni & Murwitaningsih, 2020). To help students obtain the information or solutions they need for the given challenges, problem-based learning steps employ stages like orientation, organization, investigation, presentation, analysis, and evaluation (Rizki et al., 2020).

This study aims to ascertain the impact of the Problem-based Learning Model on the Interpersonal Intelligence of Fifth Grade Students and the Learning Outcomes in Science Subjects.

Method

The experimental methods of science were used to perform the quasi-experiments. Two types of control groups were used in this study: pre- and post-test. The Control Group Design with Pre- and Post-Test Results is shown in Table 1.

Table 1. Pre-test, Post-test Control Group Design.

Sample	Beginning	Treatment	End
R	O_1	X	O_2
R	O_3	Y	O_4

Description:
R: Random Smpling
X: Treatment of Problem Based Learning
Y: Treatmen of Conventional Learning
O_1: Pretest Experimental Class
O_2: Posttest Experimental Class
O_3: Pretest Control Class
O_4: Posttest Control Class

Table 2 displays the Postest Only Control Group Desaign.

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Sample	Treatment	End
R	X	O_1
R	Y	O_3

Description:
R : Random sampling
X : Treatment of Problem Based Learning
Y : Treatment of conventional learning.
O_1 : Post-test experimental class
O_2 : Post-test control class

For the academic year 2022–2023, a total of 66 fifth-graders from SD Islam Ruhama—three classes—made up the population for this study. Random sampling or cluster random sampling is the method used to collect samples. This approach was selected since it is simple to use and takes minimal time to complete (Faenkel & Wallen, 2009). The sample included 22 members of the experimental group from the VC class and 23 members of the control group from the VA class. 45 kids make up the sampling. Data gathering methods a questionnaire's interpersonal intelligence instrument has 20 statement items with four possible responses on a Likert scale from 1 to 4. Table 3 displays the scoring on the Likert scale.

Table 3. Likert Scale Scoring

Statement	Positive	Negative
Strongly Agree	4	1
Agree	3	2
Disagree	2	3
Strongly Disagree	1	4

(Sukardi, 2019)

SS, S, TS, and STS are the options for the assertions in Table 1's Likert scale score, which includes both positive and negative claims. The 15 questions in the science exam cover a wide range of topics, including four different types of data collection. Correct answers get a score of 1 on the scientific learning achievement exam, while incorrect answers receive a score of 0. The water cycle is an important part of our planet's ecosystem, and this scientific learning achievement exam is designed to assess students' knowledge of the water cycle and their ability to analyze the water cycle's impact on Earth's events and the survival of living beings. The pupils are in elementary school fifth grade.

The learning outcome instrument is examined from the cognitive domain, which consists of C4, C5, and C6 in Bloom's taxonomy. Prior to this study, the instrument's validity and reliability had already been established in an instrument feasibility test. The study's pre- and post-tests were scored using the N-Gain process, and IBM SPSS Statistics 22 was employed for statistical analysis. Students in the experimental and control groups had their performance on learning outcomes compared using the N-gain test (Nawir et al., 2019). After making sure everything is normally distributed, the Shapiro-Wilk test is run. The Levene test is another common technique for performing this kind of assessment.

The minimum sample size for the Shapiro-Wilk normality test is 50, as stated by (Mohd Razali & Bee Wah, 2011). The Levene homogeneity test compares the dispersion of two or more populations to see how similar they are to one another (Sianturi, 2022). The hypothesis that problem-based learning improves student performance is tested using an Independent sample t-Test once the data has been standardized.

Result and Discussion

Using descriptive statistics and the IBM SPSS 22 software, we analyzed the quantitative data from the questionnaire on students' interpersonal intelligence as they learned about the water cycle in fifth grade. The results are shown in Table 4.

Table 4. Description of Interpersonal Intelligence Questionnaire Results

	N	Range	Minimum	Maximum	Means	Std. Deviations	Variances
Experiment	22	25	54	79	65.73	5.642	31.827
Control	23	24	47	71	60.04	7.016	49.225
Valid N (listwise)	22						

Table 4 summarizes the survey responses, showing that the experimental class received higher average and median scores (65.73 and 79.54, respectively) than the control group. The average score for the control group was 60.04, with a range of 47. This information can be shown in the following histogram image, in addition to using the description table above to make it simpler to interpret and draw conclusions about the survey results.

Figure 1 displays the range of results from the interpersonal intelligence questionnaire for the experimental class, which includes a higher mean score compared to the control group. Pre and post test results for the scientific learning outcomes variable are also included in Table 5.

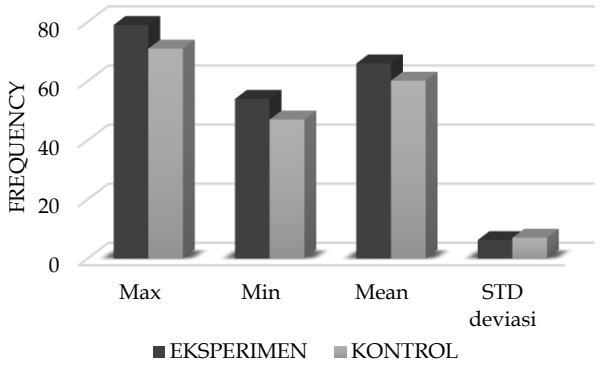

Figure 1. Interpersonal Intelligence Questionnaire Results

Table 5. Description of the Pre-test Post-test Learning Outcomes

	N	Range	Minimum	Maximum	Means	Std. Deviations	Variances
Pre-test Experiment	22	47	33	80	57.27	15.285	233.636
Post-test Experiment	22	47	53	100	82.23	13.462	181.232
Pre-test Control	23	54	26	80	49.13	13.669	186.846
Post-test Control	23	40	46	86	64.61	11.626	135.158
Valid N (listwise)	22						

Table 5 shows descriptive pre- and post-test data, and it can be seen that the pre-test value for the experimental class varied from a high of 80 to a low of 33, with an average of 57.27. The control group also performed poorly on the pretest, averaging 49.13 out of a possible 100, with scores ranging from 80 to 26. The following histogram displays this data, making it much easier to read and take inferences from the results of the preliminary test.

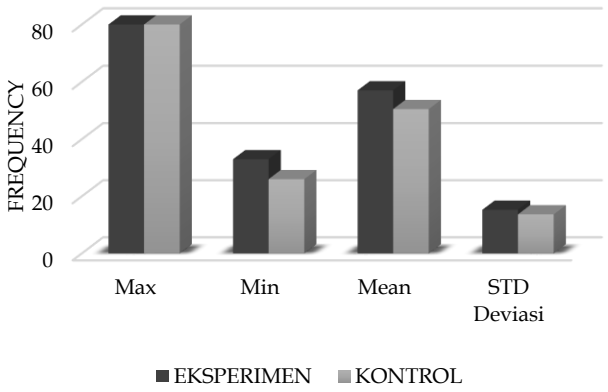

Figure 2. Control Class and Experiment Class Pre-test Results

As can be seen in Figure 2, the experimental class's pre-test results were better than the control class's in terms of mean, standard deviation, maximum value, and minimum value before the problem-based learning model treatment was implemented.

Additionally, the experimental class's post-test scores ranged from a minimum of 53 to a maximum of 100, with an average of 82.23. Additionally, the post-test in the control group reveals that the ranges are 86, 46, and 64.61, with an average of 64.61. This information can be shown in the following histogram image, in addition to using the description table above to make it simpler to interpret and draw conclusions about the post-test results.

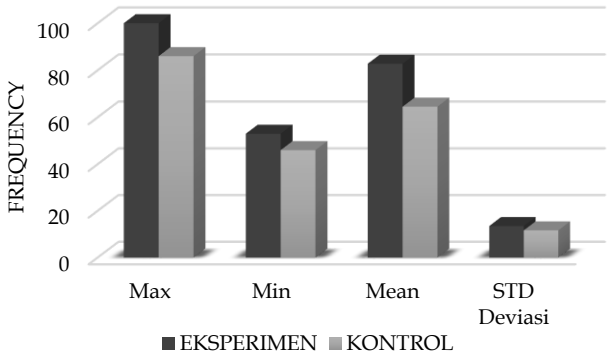

Figure 3. Control Class and Experiment Class Post-test Results

According to Figure 3, the experimental class's post-test results following the application of the problem-based learning model treatment have a maximum value, minimum value, mean, and standard deviation that are superior to those of the control class. Additionally, normality tests, homogeneity tests, N-gain testing for pre- and post-tests, and t-tests are used in inferential statistical tests through assumption tests. The results of the IQ test and the learning outcomes were analyzed using IBM's SPSS 22 software.

A normal distribution is assumed if the data pass the normality test. According to (Juliyanti et al., 2021), data distribution is typical when the p-value is > 0.05 but not typical when p-value is 0.05. If the homogeneity test has a p-value of > 0.05, then the t-test will use the result of the presumed Equal variances. The t-test will provide a result based on Equal variances if the analyzed data does not meet the assumption of homogeneity (Priyatno, 2013). The significance threshold for this t-test was 5%, or 0.05. The following conditions determine whether or not the hypothesis is true:

1. If the p-value for Ho is larger than 0.05, we accept Ho and reject Ha. That the independent variable has a negligible effect on the dependent variable is shown by these data.
2. Ho is disregarded and Ha is allowed if the significant value is less than 0.05. According to this data, the independent variable only has a limited impact on the dependent variable (Ghozali, 2018).

The discussion that follows shows test hypotheses for factors related to learning outcomes.

Interpersonal Intelligence Variable Assumption Test

The outcomes of the learning outcomes normality test are displayed in the table below.

Table 5. Interpersonal Intelligence Questionnaire Normality Test

		Shapiro-Wilk		
	Class	Statistics	df	Sig.
Interpersonal Intelligence	Experiment	.116	22	.948
	Control	.148	23	.348

The Shapiro-Wilk normality test findings are shown in Table 5, with the experimental group showing a significance level of 0.945 and the control group showing a level of 0.348. It is probable that the data follows a normal distribution since the significance threshold for both normality test results is greater than 0.05. The next section provides an analysis of the homogeneity of the interpersonal intelligence variable.

Test of interpersonal IQ homogeneity

Table 6. Interpersonal Intelligence Questionnaire Homogeneity Test

		Levene Statistics	df1	df2	Sig.
Interpersonal Intelligence	Based on Means	2038	1	43	.161
	Based on Median	2024	1	43	.162

According to the homogeneity test, the significance level based on the mean value is 0.161. Data homogeneity was inferred from the Levene value being more than 0.05 and the similar variance in this study. The hypothesis test is then determined by an application of the t-test and the independent sample t-test. The following table shows the results of the computation for the hypothesis test.

Table 7. Interpersonal Intelligence t-test

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Differences	Std. Error Difference	95% Confidences Interval Of The Difference	
							Lower	Upper
Interpersonal Intelligence	Equal variances assumed	5.986	43	.005	5.684	1903	1.846	9.522

Table 7 shows that assuming equal variances (2-tailed) yields a significant value of 0.005 < 0.05. Ho is refuted and Ha is accepted in terms of the criteria used to make judgments while testing a hypothesis. The problem-based learning technique therefore significantly improves students' interpersonal intelligence in class V scientific courses.

Studies (Saufi & Royani, 2016) found that the problem-based learning technique was superior to traditional learning in terms of students' self-confidence and interpersonal intelligence, and the results of this study are consistent with those findings. Findings from research (Amrullah & Suwarjo, 2018) indicate that the problem-based learning method promoted students' development of interpersonal intelligence. The results of this study also corroborate research (Fauzi et al., 2018) demonstrating a considerable increase in students' interpersonal intelligence when using a problem-based learning strategy.

The assumption test for the learning outcomes variable follows, as will be demonstrated in the discussion that follows.

Test the Assumptions of Learning Outcomes Variables

To evaluate if the N-Gain formula enhances student learning outcomes. The category of interpretation for N-Gain's efficacy is displayed in the following table.

Table 8. Category interpretation of the effectiveness of N-Gain

Percentage (%)	Interpretation
<40	Ineffective
40-55	Less Effective
56-75	Effective enough
>76	Effective

(Arikunto, 1999)

The results of the N-gain pre-test post-test can be seen from Table 9.

Table 9. N-Gain Test Pre-test Post-test Learning Outcomes

Class	Pre-test	Post-test	N-Gain (%)	Information
	Means	Means	Means	
Experiment	57.27	82.23	61.29	Effective enough
Control	49.13	64.61	30.11	Ineffective

Using the N-Gain test results shown in table 9. Effectiveness data reveals an average N-Gain of 61.29 throughout the experimental group. Despite the fact that the category average control class size is 30.11 and the N-Gain value is quite effective, this figure is ineffectual.

The normalcy test and its computation are both detailed below. The Table 10 the results of the normalcy test computation.

Table 10. N-Gain Normality Test of Learning Outcomes

		Shapiro-Wilk		
	Class	Statistics	df	Sig.
NGain_Persen	Experiment	.949	22	.301
	Control	.938	23	.163

As can be seen in Table 5, the results of the normality test using the Shapiro-Wilk test indicate that the significance level of the experimental class learning outcomes variable is 0.301 > 0.05, whereas the significance level of the control class learning outcomes variable is 0.163 > 0. 05. If the p-value is more than 0.05, then the data follow a normal distribution. The following discussion further examines whether or not the learning outcomes variable is consistent. The table

that follows shows the results of the homogeneity test computation.

Table 11. N-Gain Homogeneity Test of Learning Outcomes

	Levene Statistics	df1	df2	Sig.
Based on Means	5.306	1	43	.026
Based on Median	5.241	1	43	.027

The homogeneity test findings achieved a significance value based on the mean of 0.026 based on table 11. The results in this study suggest that the variance is not homogenous, as shown by the Levene value of 0.05. Then comes the t-test with independent sample t-test for hypothesis testing. Check your idea about learning consequences. Table 12 shows the outcomes of the independent sample t-test.

Table 12. N-Gain t-test of Learning Outcome Scores

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Differences	Std. Error Difference	95% Confidence Interval Of The Difference	
							Lower	Upper
NGain_ Percent	Equal variances not assumed	5.657	35.893	.000	31.18188	5.51180	20.00229	42.36148

Inequality of Variances Test by Levene Table 12 shows that the variances for the experimental and control classes are unequal, as shown by the sig value of 0.026 for the N-Gain data (percent). In the independent t-test, the N-Gain value is determined not by the expected table but by the significant value in the Equal variances.

In light of what has been said above, the significance level (2-tailed) is 0.000 0.05. According to the standards used while evaluating hypotheses, Ho is incorrect whereas Ha is correct. This indicates a difference in how the experimental and control groups view success in learning. Class V science education at SD Islam Ruhama is greatly aided by the use of problem-based learning paradigms as opposed to more conventional ones. This demonstrates that there is a direct correlation between using a problem-based approach and increased student understanding of scientific principles.

The Problem-based Learning paradigm has been shown to improve learning results. (Boye & Agyei, 2023) and is consistent with the findings of this study. Research shows that the PBL paradigm can improve students' performance in school by an average of 43.6% (Robiyanto, 2021) This study's findings corroborate those of a prior study (Sulastry et al., 2023) that found problem-based learning to significantly improve retention and application of knowledge. In addition, (Mulyanto et al., 2018) incorporated their study's results into other relevant work to the present study. In mathematics specifically, problem-based learning has been shown to improve student achievements. This research explores scientific lessons while learning mathematics (Mulyanto et al., 2018), which is different from research (Mulyanto et al., 2018) in terms of the subject content. The variables and techniques employed represent yet another difference.

Conclusion

One may argue that because the significance value of < 0.05 is related to the criteria for making decisions when testing a hypothesis, Ho is rejected while Ha is approved. First off, the paradigm shift toward Problem Based Learning has a noticeable effect on increasing students' interpersonal intelligence. Second, problem-based learning really makes it easier for children to study science.

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Conceptualization, F.N. and M.; software, F.N.; validation, M.; writing—original draft preparation, F.N.; writing—review and editing, F.N. and M.

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The authors declare no conflict of interest

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