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Investigating the Effect of Project-Based Learning on the Science Learning Outcomes of Fifth Grade Students in Elementary School

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A B S T R A C T

This study aims to examine the impact of implementing the Project-Based Learning (PjBL) model on the academic achievement of fifth-grade students in the subject of Science and Social Studies (IPAS) at SDN Meruya Utara 08 Pagi. The research employed a quasi-experimental design involving two groups: an experimental group taught using the PjBL approach and a control group that received conventional instruction. Data were collected through multiple-choice tests that had undergone content validation and reliability testing. The analysis revealed that the average score of students in the experimental group was 85.74, while the control group obtained an average of 71.00. Statistical analysis using an Independent Sample t-Test yielded a significance value of 0.000 ($p < 0.05$), indicating a meaningful difference between the two groups. Furthermore, the effect size analysis using Cohen's d produced a value of 2.142, which falls into the category of a large effect. These findings demonstrate that the application of the PjBL model has a positive and substantial influence on students' IPAS learning outcomes, offering an effective alternative strategy for enhancing student engagement and deepening conceptual understanding.

1. Introduction

Education is a learning process that involves all efforts and activities to develop individual potential. It is a lifelong learning process that continues until the end of life, encompassing various aspects that enable humans to acquire knowledge, skills, and values to enhance the quality of human resources (Hudin et al., 2024). Basic education plays a crucial role as the foundation in shaping a student's character to develop strong foundational skills (Ramadianti, 2021). Education also plays a vital role in nurturing a quality future generation for the nation. One of the many indicators of educational success is the achievement of optimal learning outcomes at every level of education (Zahroh & Hilmiyati, 2024). Student success indicators can determine their future prospects, hence meaningful learning is essential. Natural

and Social Sciences (IPAS) significantly contribute to enhancing students' competencies by integrating elements of natural and social sciences in a cohesive manner within the context of daily life (Syafruddin et al., 2025). Although the IPAS subject has been widely implemented at the elementary school level, students' academic achievement in this subject has not yet reached the optimal category. One possible cause of low learning outcomes is the lack of diversity in teaching methods, where conventional teacher-centered approaches still dominate, resulting in students often playing a passive role as recipients of material without active engagement.

In the context of learning at SDN Meruya Utara 08 Pagi, the main problem faced is the low level of academic achievement of students in the IPAS subject. This situation correlates with a significant number of students facing difficulties in mastering the learning content, which is largely due to the lack of variety in the instructional approaches applied in the classroom. The learning process, which tends to be monotonous and does not encourage active student involvement, is a factor that hinders the effectiveness of learning. As a result, students' needs for optimal learning experiences are not being met. Therefore, it is important to implement innovative learning approaches that encourage active student participation in order to strengthen their understanding during the learning process. The Project-Based Learning model is considered a pedagogical strategy that is in line with the needs of the contemporary education system. This method encourages active participation of students through project activities that are directly related to real-world situations (Mutawally, 2021). This is in line with the context of 21st-century education, which emphasizes the importance of developing critical thinking, collaboration, and individual creativity (Riskayanti, 2021). This also places students at the center of student-centered learning (Istiqomah et al., 2023), which aims to practically and relevantly improve their learning outcomes.

Based on the issues outlined above, the researcher was motivated to seek solutions through the application of the PjBL learning model. This study aims to examine the effectiveness of the PjBL model on the learning outcomes of fifth-grade students in the IPAS subject at SDN Meruya Utara 08 Pagi. The findings of this study are expected to serve as an empirical basis for the development of contextual learning models at the elementary school level. These findings are consistent with a previous study by Puspitasari et al. (2024), which stated that the use of the PjBL model significantly influenced student learning achievement in IPAS subjects at the elementary school level, when compared to traditional learning approaches.

2. Methodology

This study uses a quantitative approach with a quasi-experimental research design as its methodological framework. The research design includes two class groups Rahmawati et al. (2023), namely the experimental group, which received IPAS learning through the implementation of the PjBL learning model, and the control group, which received learning using a conventional approach. Class selection was

non-random, but both classes were ensured to have equivalence in academic characteristics and learning environments.

All fifth-grade students at SDN Meruya Utara 08 Pagi in the 2024/2025 academic year were included as the research population, totaling 62 students. Given the limited number of participants and the suitability of class characteristics, total sampling technique was used to determine the sample. Two classes were selected as research subjects, namely class V-A as the experimental group and class V-B as the control group, each consisting of 31 students.

Data collection was conducted using a test instrument in the form of objective multiple-choice questions, which were compiled based on learning outcome indicators on the topic of "Harmonious Ecosystems" in the IPAS subject. Before being used in the study, the instrument was tested for validity and reliability with a total of 40 multiple-choice questions. Validity testing was conducted using Point-Biserial correlation, while the reliability of the instrument was analyzed using Cronbach's Alpha formula processed with the assistance of IBM SPSS statistical software.

After the instrument was proven to meet the validity and reliability criteria, the next stage was to test the prerequisites for analysis. Normal distribution was tested using the Liliefors method, while the uniformity of variance between groups was analyzed using Levene's Test. The analysis of differences in learning outcomes between the experimental and control groups was conducted using the Independent Sample T-Test technique, while the magnitude of the treatment effect was calculated using the effect size method with Cohen's d.

The implementation of this research followed a series of systematic stages, starting from the initial planning process, intervention implementation, to the final evaluation stage. In the preparation stage, the researcher compiled administrative steps such as applying for permission from the school, establishing communication and coordination with the principal and homeroom teachers, preparing learning tools and measuring instruments, and conducting validity and reliability tests on the instruments.

The next stage was the implementation of the research activities involving two classes as samples, namely the experimental group and the control group. The learning process in this stage was carried out by applying the Project-Based Learning (PjBL) model in the experimental group, while the control group followed traditional learning methods. After the learning process, both groups were given a final test to see the differences in learning outcomes between the two different models.

In the final stage, the researcher processed and analyzed the test results using a statistical approach to determine the significance of the differences between the two groups and to test the established hypothesis. Overall, this was aimed at examining the extent of the influence of the PjBL model on IPAS learning outcomes among fifth-grade students at SDN Meruya Utara 08 Pagi.

3. Results and Discussion

Initial Conditions of the Experimental and Control Groups

At the outset of the study, both the experimental and control groups were carefully selected to ensure comparability. The experimental class (V-A) consisted of 31 students, with an equal distribution of genders: 21 males and 10 females. Similarly, the control class (V-B) also comprised 31 students, with 21 males and 10 females. Both classes were taught by the same teacher to minimize any potential bias arising from differences in teaching styles or classroom management.

The classroom environments for both groups were comparable in terms of physical setup, lighting, and seating arrangements. However, the learning atmosphere differed significantly due to the implementation of the PjBL model in the experimental group. In the experimental class, the environment was more dynamic and interactive, with students frequently engaging in group discussions, hands-on activities, and collaborative problem-solving. In contrast, the control class followed a more traditional lecture-based approach, where students primarily listened to the teacher's explanations and completed individual assignments.

Description of the Project-Based Learning (PjBL) Model Implementation

The PjBL model was implemented in the experimental class for two days. Students were divided into five groups. Each group was tasked with designing and implementing a science experiment related to ecosystems, focusing on efforts to maintain a balanced and harmonious ecosystem.

The project began with an introductory session where students were introduced to the topic of ecosystems and provided background information about their components. They were then invited to observe examples of simple ecosystems and describe how living things influence each other in their environment. Throughout the project, students were encouraged to use creative thinking in creating ecosystem models or conducting simple experiments. The teacher acted as a facilitator, providing assistance and guidance as needed by students throughout the project.

Each group was required to present their work in a final presentation, which included a simple written report, a visual display of the ecosystem model, and an oral explanation of their learning. This approach aimed to develop scientific knowledge as well as skills in communicating ideas and working collaboratively in groups.

Validity and Reliability Test Results

The validity of the instrument was first tested at SDN Meruya Utara 12 Pagi, involving 30 students as the pilot sample. The measurement tool in this study was an objective multiple-choice test consisting of 40 items, which had been validated and reliability-tested to ensure its suitability for accurately measuring students' learning outcomes. The validity test was conducted using the Point Biserial

correlation technique, which is appropriate for dichotomous variables such as correct or incorrect answers in multiple-choice questions (Arsyi & Gideon, 2024). Validity was determined based on the criterion that if the value of $r_{hitung} > r_{tabel}$, then the item was considered valid (Nurhalimah et al., 2022). The data analysis results showed that out of 40 items, 35 were deemed valid and 5 were invalid. The validity was deemed satisfactory with a r_{tab} value of 0.361 at a significance level of 5%. The data related to the validity testing of the instrument in this study are presented in Table 1.

Table 1. Instrument Validity Test Output

Results	Question Item Code	Total
Valid	"1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 33, 34, 35, 36, 37, 38, 39, 40"	35
Invalid	"11, 18, 22, 31, 32"	5
	Total	40

After validity testing, the data was reprocessed to test its reliability using Cronbach's Alpha formula, a statistical measure applied to assess the reliability (internal consistency) of a research instrument, such as a questionnaire or survey. This measures the extent to which the items in an instrument consistently measure the same thing (Maryono, 2022). The reliability test results yielded r_{hitung} 0.946 and r_{tabel} 0.361 at a significance level of 5% with 30 questions. Therefore, $r_{hitung} > r_{tabel}$, and the results are classified as reliable. Table 2 below presents the reliability test results for the research instrument.

Table 2. Reliability Statistics

Reliability Statistics	
Cronbach's Alpha Value	Number of Items
.946	40

Based on the results of validity and reliability testing, the measurement tool in this study was deemed feasible and met the criteria as a measurement tool. A total of 35 items were found to be valid through the Point Biserial correlation test, while the reliability was very strong with a Cronbach's Alpha coefficient of 0.946. Thus, the instrument is valid and reliable for measuring IPAS learning performance in fifth-grade elementary school students.

After the instrument was tested, the next step was data collection, which took place at SDN Meruya Utara 08 Pagi. Data was obtained by administering tests to two classes: V-A as the experimental class where the PjBL model was applied, and V-B as the control class receiving conventional instruction. Test results for the experimental class showed the highest score of 98 and the lowest of 74. The distribution of student scores is as follows: two students scored 74, four students scored 78, six students scored 82, eight students scored 86, six students scored 90, three students scored 94, and two students scored 98. The distribution of these results is visualized through histogram and polygon graphs which can be seen in Figure 1 below:

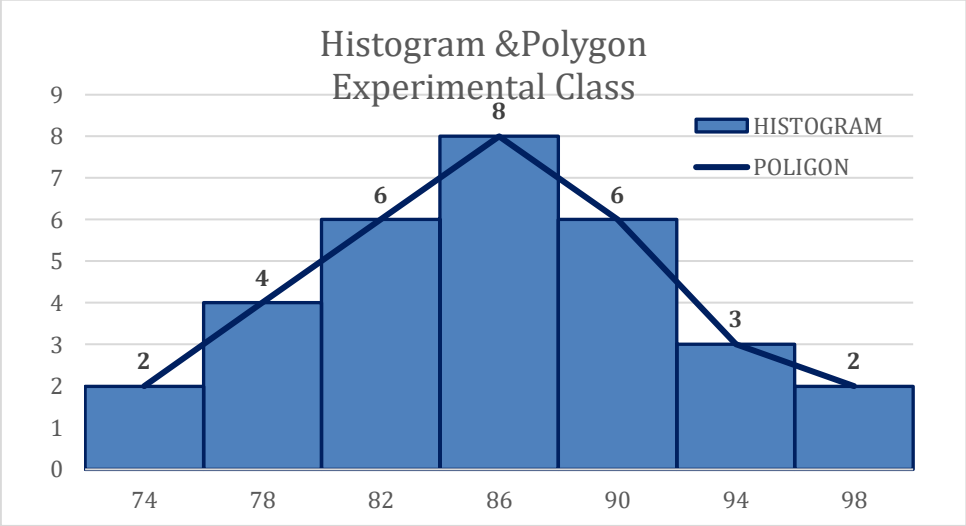

Figure 1. Histogram and polygon representation of IPAS test scores in the experimental group

The highest score achieved by students in the control group was 83, while the lowest score was 57. Two students scored 57, four students scored 62, seven students scored 67, eight students scored 72, six students scored 77, and four students scored 83. The distribution of the IPAS test scores of the control group is visualized through histogram and polygon graphs as presented in Figure 2 below:

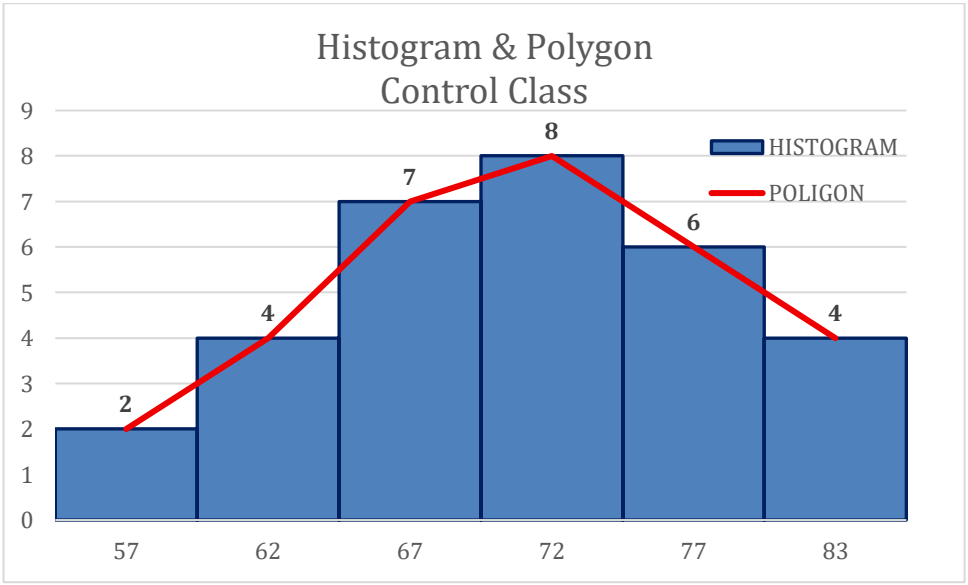

Figure 2. Visualization of Histogram and Polygon of IPAS Test Scores in the Control Group

Prerequisite Analysis Test

Before conducting the hypothesis test, a prerequisite analysis test was first carried out to ensure that the data obtained met the parametric statistical assumptions. The initial step in the data analysis process was a normality test to determine whether

the learning outcomes of students from the experimental and control groups were normally distributed (Sonjaya et al., 2025). This test used the Kolmogorov-Smirnov method with Lilliefors correction. The decision is based on the significance value: if the Sig. value is greater than 0.05, the data has a normal distribution; conversely, a Sig. value ≤ 0.05 indicates a non-normal distribution (Quraisy, 2022). The analysis was carried out using SPSS software, and the results of the normality test are presented in Table 3 below:

Table 3. Summary of Normality Test

Class		Kolmogorov-Smimov[a]			Shapiro-Wilk		
		"Statistic"	"df"	"Sig."	"Statistic"	"df"	"Sig."
Score	Experimental Class	0,129	31	.200*	0,958	31	0,266
	Control Class	0,135	31	0,162	0,942	31	0,094

*. This is the actual lower limit of significance
a. Liliefors Significance Correction

The Kolmogorov-Smirnov normality test with Lilliefors correction yielded significance values of 0.200 for the experimental group and 0.162 for the control group. Since both values are above the threshold of 0.05, it can be said that the data distribution is normal. This is further supported by the results of the Shapiro-Wilk test, which yielded values of 0.266 for the experimental group and 0.094 for the control group. Thus, the condition for a normal distribution is met, and the data is suitable for further analysis.

The next step is to conduct a homogeneity test to examine the equality of variances between groups (Naitili & Nahak, 2023). This test is performed using Levene's Test, where a significance level above 0.05 indicates that the variances between groups are homogeneous. Conversely, if the significance value is less than 0.05, it indicates that the variances are not homogeneous (Agustian et al., 2025). Data processing was performed using SPSS software. The results of the homogeneity test are presented in Table 4 below:

Table 4. Homogeneity Test Results

		"Levene Statistic"	"df1"	"df2"	"Sig."
Score	Analysis using the Mean	0,894	1	60	0,348
	Median-based analysis	0,644	1	60	0,426
	Median-based analysis with adjusted degrees of freedom	0,644	1	58,828	0,426
	Trimmed Mean approach	0,846	1	60	0,361

The results of the homogeneity analysis using Levene's Test show that the significance value for the mean is 0.348, for the median and the median adjusted for degrees of freedom is 0.426, and for the trimmed mean is 0.361. All values exceed the significance threshold of 0.05, so it can be said that there is no significant difference in variance between the two groups. Thus, the assumption of variance homogeneity has been met.

Hypothesis Testing

After ensuring that all statistical analysis requirements were met, a hypothesis test was conducted using the Independent Samples t-Test method to determine whether there was a statistically significant difference in the average learning outcomes between the experimental and control groups (Wahyudi et al., 2023). The decision-making criteria are based on the significance value (Sig. 2-tailed): if the significance value obtained exceeds 0.05, then the null hypothesis (H_0) is accepted and the alternative hypothesis (H_1) is rejected. Conversely, if the value is below 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted. Details of the t-test analysis results are presented in Table 5 below:

Table 5. Independent Sample t-Test Results

		"Equality of Variances"		"t-test for Equality of Means"						
									"Interval of the"	
		"F"	"Sig."	"t"	"df"	"Sig. (2-tailed)"	"Mean Difference"	"Std. Error Difference"	"Lower"	"Upper"
Value	Equal variance assumed	0,894	0,348	8,433	60	0,000	14,742	1,748	11,245	18,239
	Equal variance not assumed			8,433	58,753	0,000	14,742	1,748	11,244	18,240

The results of the Independent Samples t-Test analysis showed a two-tailed significance value of 0.000. Since this value is smaller than the threshold of 0.05, it can be concluded that the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. The results indicate a significant difference between the experimental and control groups, and prove that the implementation of the PjBL learning model has a positive contribution to the learning outcomes of fifth-grade students at SDN Meruya Utara 08 Pagi.

Effect Size

The next step in the analysis process is to calculate the effect size using Cohen's d formula. This technique aims to measure the extent of the effect of the treatment given, even though the differences found have been declared statistically significant (Kumaret al., 2022). The results of the Effect Size calculation are presented in Table 6:

Table 6. Results of the Effect Size Test

Class:	**Average:**	**Standar Deviasi**	**Effect size (Cohen's d)**	**Description**
Experiment	85,74	6,361	2,142	(*Large Effect Size*)
Control	71,00	7,367		

In the data analysis results, it was found that the average learning outcome score for the experimental group was 85.74 with a standard deviation of 6.361, while the control group had an average of 71.00 and a standard deviation of 7.367. This difference in average scores of 14.74 indicates a significant gap between the two groups. The Effect Size analysis through the Independent Sample t-Test yielded an effect size (Cohen's d) of 2.142, which falls into the large effect size category. According to Metsämuuronen (2024), an effect size of 0.2 is categorized as small, 0.5 as moderate, and 0.8 as large. Thus, the difference in achievement between the experimental and control groups is not only statistically significant but also reflects a substantial and meaningful practical impact.

These findings indicate that the implementation of the Project-Based Learning (PjBL) model has a constructive influence on the learning performance of fifth-grade students at SDN Meruya Utara 08 Pagi. Referring to the Minimum Competency Criteria (KKM) of 70, all students in the experimental class successfully met the competency standards, with an achievement rate of 100%. Meanwhile, only 58.06% of students in the control class achieved mastery, while the remaining 41.93% did not meet the MCC.

Outcomes of the Student Projects

The projects produced by students in the experimental class demonstrated a high level of engagement and creativity, reflecting their deep understanding of scientific concepts and their ability to apply theoretical knowledge to real-world scenarios. One notable project involved the creation of an interactive model of the marine ecosystem which can be seen Figure 3 below:

Figure 3. Interactive Marine Ecosystem Model

After studying the material, students can understand the importance of maintaining balance between living things and their environment. Students can grow into individuals who care for nature, understand the impact of human behavior on the environment, and learn to utilize natural resources wisely.

The findings of this study indicate that the implementation of the Project-Based Learning (PjBL) approach plays a significant role in supporting IPAS learning outcomes for fifth-grade students at SDN Meruya Utara 08 Pagi. The PjBL model encourages active student involvement, fosters a sense of responsibility in completing tasks independently or collaboratively, and develops skills through contextual and meaningful learning experiences. These elements collectively contribute to enhanced learning outcomes.

These findings indicate that the PjBL model has high potential for optimizing the overall learning process (Andirasdini & Fuadiyah, 2024). This model is highly relevant for science learning because it encourages students to actively engage in solving contextual problems, work collaboratively, and be creative in finding solutions (Aini et al., 2022; Perayani & Rasna, 2022). The results of this study are consistent with the findings of Taupik and Fitria (2021), proving that the PjBL approach can significantly influence science learning outcomes at the elementary school level.

4. Conclusion

The findings of this study indicate that the implementation of the Project-Based Learning (PjBL) approach plays a significant role in supporting IPAS learning outcomes for fifth-grade students at SDN Meruya Utara 08 Pagi. The PjBL model encourages active student involvement, fosters a sense of responsibility in completing tasks independently or collaboratively, and develops skills through contextual and meaningful learning experiences. These elements collectively contribute to enhanced learning outcomes.

The results demonstrate that the PjBL approach not only produces statistically significant improvements but also has a strong practical impact on student competencies. By promoting an active role for students, the project-based learning model strengthens conceptual understanding, increases engagement during the learning process, and shapes more meaningful and contextually relevant learning experiences, particularly in the context of IPAS learning. This reinforces the effectiveness of PjBL as a pedagogical strategy that aligns with the principles of active and experiential learning.

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