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Research Article

Problem-Based Learning Model in Elementary School Students: Learning Activity and Learning Outcomes

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ABSTRACT

Purpose of the study: This study investigates the effectiveness of the Problem-Based Learning (PBL) model in improving learning activity and learning outcomes of elementary school students in IPAS (Science and Social Studies) learning within the context of the Merdeka Curriculum implementation.

Methodology: A quantitative approach was employed using a quasi-experimental posttest non-equivalent control group design. The participants consisted of 22 third-grade students at SDN 02 Nambangan Lor, Madiun City, divided into an experimental class (n = 11) taught using the PBL model and a control class (n = 11) taught using a traditional learning model. Data were collected through learning activity observation sheets and learning outcome tests, then analyzed using descriptive statistics and independent sample t-tests with a significance level of 0.05.

Main Findings: The results show that students in the experimental class demonstrated significantly higher learning activity and learning outcomes compared to those in the control class. The independent sample t-test revealed a significant difference in learning activity ($t = 4.129$, $p < 0.05$) and learning outcomes ($t = 5.744$, $p < 0.05$) between the two groups. These findings indicate that the PBL model is more effective than traditional learning in fostering active student participation and improving academic achievement.

Novelty/Originality of this study: This study provides empirical evidence supporting the integration of Problem-Based Learning as an instructional strategy to enhance the quality of IPAS learning in elementary schools, particularly in alignment with the student-centered principles of the Merdeka Curriculum.

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1. INTRODUCTION

Basic education plays a strategic role in realizing the National Education Goals, namely developing the potential of students to become people who believe in and fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens [1]-[3]. To achieve these goals, the Indonesian government continues to reform the education system through curriculum transformation, one of which is by implementing the Independent Curriculum at various levels of education, including Elementary Schools. The Independent Curriculum as stipulated in Regulation of the Minister of

Education, Culture, Research, and Technology of the Republic of Indonesia Number 12 of 2024 emphasizes the principles of student-centered learning, learning differentiation, and strengthening the Pancasila Student Profile. This curriculum requires students to be actively, creatively, and reflectively involved in the learning process [4]-[9]. However, the implementation of the Independent Curriculum in the field still faces various challenges, particularly in the learning of Natural and Social Sciences (IPAS), which demands conceptual integration, relevance to everyday life contexts, and student engagement in the learning process.

Active learning is a crucial aspect of meaningful learning. Active learning encompasses students' physical and mental engagement in the learning process, while learning outcomes are changes in student behavior across the cognitive, affective, and psychomotor domains as a result of the learning experience [10]-[14]. High student engagement positively correlates with optimal learning outcomes. However, initial observations in grade III of SD Negeri 02 Nambangan Lor, Madiun City, indicated that student engagement in the IPAS subject was still relatively low. Of the 29 students, only 7 (24.1%) were classified as active, while 22 (75.9%) were categorized as less active. This situation directly impacted student learning outcomes, with only 10 students (34.7%) achieving the Learning Objective Completion Criteria, while 19 students (65.3%) failed to achieve this. This finding indicates a serious problem in the science learning process that requires appropriate pedagogical intervention.

The low student engagement and learning outcomes are linked to several factors. The lack of student engagement in learning is often caused by monotonous, teacher-centered learning methods [15]-[19]. Learning dominated by lectures without providing space for students to ask questions, discuss, or explore tends to reduce student interest and engagement. However, student engagement in asking questions is a crucial aspect of learning, as it allows students to clarify their understanding and deepen their mastery of the material [20]-[24]. Furthermore, student engagement is also a crucial prerequisite for realizing changes in knowledge, attitudes, and skills during the learning process [25]-[27]. Field evidence shows that science learning at Elementary School 02 Nambangan Lor is still dominated by lectures, lacks variety, and fails to connect learning materials to students' daily lives. This contradicts the demands of the Independent Curriculum, which requires teachers to act as facilitators and innovators, implement project-based learning (P5), conduct holistic and ongoing assessments, and continuously develop teacher professional competencies.

In line with these demands, a learning model is needed that can encourage student engagement, improve learning outcomes, and is relevant to the characteristics of the Independent Curriculum. One learning model deemed appropriate is Problem-Based Learning (PBL). PBL is a learning approach that places real-world problems as the primary context for learning concepts and skills, thus encouraging students to think critically, collaborate, and construct their knowledge independently [28]-[30]. The primary goal of PBL is not only to convey knowledge but also to develop critical thinking and problem-solving skills. Furthermore, PBL helps students become independent and autonomous learners through teacher guidance that encourages students to ask questions and seek solutions to real-world problems [31]-[33].

Several previous studies have shown that implementing the PBL model can improve student engagement and learning outcomes. However, most previous research has focused on specific levels and subjects and has not specifically examined the application of PBL in science learning in lower elementary school grades within the context of the Merdeka Curriculum implementation. Thus, there is a research gap in the form of limited research that empirically examines the effectiveness of the Problem-Based Learning model in improving the activeness and learning outcomes of third-grade elementary school science students, particularly in schools that have implemented the Merdeka Curriculum.

2. RESEARCH METHOD

The researcher's research design is quantitative, using a quasi-experimental posttest non-equivalent control group design. It was done to investigate causal hypotheses by comparing one or more experimental groups that received treatment with a comparison group that did not. This research design was implemented because it aligned with the research objectives, which aimed to determine whether the problem-based learning model could improve student activity and learning outcomes. This study used descriptive statistics (average, minimum, and maximum) and inferential statistics. The inferential statistic used was the independent sample t-test.

Tabel 1. Posttest Non-Equivalent Control Group Design

Group	Pretest	Treatment	Posttest
Experimental	O_1	Using the problem-based learning model	O_1
Control	O_2	Traditional Learning model	O_2

This research was conducted at Elementary School 02 Nambangan Lor, Madiun City, with a total of 22 third-grade students. There were 11 students in the experimental class and 11 students in the control class. The experimental class used the Problem-Based Learning Model, while the control class used the Traditional

Learning Model. The sample collection technique used was purposive sampling. Purposive sampling is a sampling technique based on the researcher's criteria. In this study, the first step in the data collection process was to provide intervention only to the experimental class using the Problem-Based Learning Model. In contrast, the control class used Traditional Learning. The results of the assessment of student activities and learning outcomes were then compared between students who used the Problem-Based Learning Model and students who did not use the model. The instruments used were a learning activity observation sheet and a test for learning outcomes. The learning activity observation sheet used a 4-point Likert scale. Less active received a score of 1, moderately active received a score of 2, active received a score of 3, and very active received a score of 4. Meanwhile, the learning outcomes used 10 multiple-choice questions with a maximum score of 100.

The following are the categories of student learning activities and learning outcomes, including very good, good, sufficient, not good, and very poor, as shown in Table (2-3).

Table 2. Categorization of learning activity

Category	Interval
Very Good	12.1 – 16.0
Good	8.1 – 12.0
Moderate	4.1 – 8.0
Not Good	1.0 – 4.0

And category for learning outcome in Tabel 3.

Table 3. Categorization of learning outcome

Category	Interval
Very Good	75.1 – 100.0
Good	50.1 – 75.0
Moderate	25.1 – 50.0
Not Good	0.0 – 25.0

All data obtained from the observation sheet of student learning activities and tests for student learning outcomes in the control and experimental classes were collected, then calculated and analyzed using SPSS 21. Descriptive statistics were used to calculate the frequency, percentage, average, minimum, and maximum for the control and experimental groups. In this study, quantitative data were analyzed using parametric statistics, including independent sample t-tests. Independent sample t-tests were conducted to test differences in student learning activities and outcomes in the application of the Problem Based Learning learning model. This study used SPSS 21 at a significance level of 0.05.

3. RESULTS AND DISCUSSION

This section describes the research findings on student learning activity and learning outcome. The results of the Category, Mean, Min, Max, and Percentage of the posttest, which show the impact of Problem Based Learning learning model on learning activity and learning outcome among elementary school students, are presented as follows.

Table 4. Gaps in Learning Activity Students' Scores

	Interval			Mean	Min	Max	%
	Range	Category	Total				
Class Experiment	1.0 – 4.0	Not very good	0	10	9	15	0.0
	4.1 – 8.0	Not good	0				0.0
	8.1 – 12.0	Good	8				72.7
	12.1 – 16.0	Very good	3				27.3
	TOTAL		11				100
	Interval			Mean	Min	Max	%
	Range	Category	Total				
Class Control	1.0 – 4.0	Not very good	3	9	3	11	27.3
	4.1 – 8.0	Not good	7				63.6
	8.1 – 12.0	Good	1				9.1
	12.1 – 16.0	Very good	0				0.0
	TOTAL		11				100

From table 4, which comes from 11 respondents of Elementary School Students, is categorized as good in the experimental class, and after being processed and the results obtained using the SPSS 21 program application, it was found that the learning activity in the experimental class has a good category of 72.7% for 8 students from a total of 11 students, and very good at 27.3% for 3 students from a total of 11 students. Of the 11 students, the average is 11, the maximum is 15, and the minimum is 9. Then in the control class which comes from 11 respondents, the dominant category is not good, and after being processed and the results obtained using the SPSS 21 program application, it was found that the learning activity of students in the control class has a not good category of 63.6% for 7 students from a total of 11 students, good at 9.1% for 1 students from a total of 11 students, very not good at 27.3% for 3 students from a total of 11 students. The 11 students had an average score of 9, a maximum score of 11, and a minimum score of 3.

Table 5. Gaps in Learning Outcome Students' Scores

	Interval			Mean	Min	Max	%
	Range	Category	Total				
Class Experiment	75.1 – 100.0	Very Good	9	85	71	90	81.8
	50.1 – 75.0	Good	2				18.2
	25.1 – 50.0	Moderate	0				0.0
	0.0 – 25.0	Not Good	0				0.0
	TOTAL		11				100
	Interval			Mean	Min	Max	%
	Range	Category	Total				
Class Control	75.1 – 100.0	Very Good	0	50	25	72	0.0
	50.1 – 75.0	Good	3				27.3
	25.1 – 50.0	Moderate	7				63.6
	0.0 – 25.0	Not Good	1				9.1
	TOTAL		11				100

From table 4, which comes from 11 respondents of Elementary School Students, is categorized as good in the experimental class, and after being processed and the results obtained using the SPSS 21 program application, it was found that the learning activity in the experimental class has a very good category of 81.8% for 9 students from a total of 11 students, and good at 18.2% for 2 students from a total of 11 students. Of the 11 students, the average is 85, the maximum is 90, and the minimum is 71. Then in the control class which comes from 11 respondents, the dominant category is moderate, and after being processed and the results obtained using the SPSS 21 program application, it was found that the learning outcome of students in the control class has a moderate category of 63.6% for 7 students from a total of 11 students, good at 27.3% for 3 students from a total of 11 students, very not good at 9.1% for 1 students from a total of 11 students. The 11 students had an average score of 50, a maximum score of 72, and a minimum score of 25.

This comparison shows that traditional learning model fails to meet students' need for active participation. At the same time, Problem Based-Learning model provide a more contextual, applicable, and problem-solving learning experience, thus encouraging improved student academic achievement.

Table 6. Independent sample t-test for learning activity

	t	df	Mean	Std.Deviation	*95% confidence interval*	
					Lower	*Upper*
Learning Activity	4.129	22	3.2092	.14312	8.219	.6866
	4.129	2.074	2.6510	.20111	7.645	.8322

From table 5 it can be seen that the value obtained (t count) with the t table value. The t table value can be found in the t table with a significance value of 0.05 (2-sided test) with degrees of freedom (df) 22. In this study, the results for the t table are 2.074. While for the t count value can be seen in table 5 (t column) which is 4.129. The criterion for testing the hypothesis is the rejection value of H0. So, it can be concluded that there is a significant difference in student learning activities between the control class taught using the traditional learning model and the experimental class using the problem based learning model. It can be seen from table 5 that the average value of student learning activities is 3.2092, which means it can increase student learning activities.

Table 7. Independent sample t-test for learning outcome

	t	df	Mean	Std.Deviation	*95% confidence interval*	
					Lower	*Upper*
Learning Outcome	5.744	22	3.2192	.14321	8.263	.6132
	5.744	2.074	2.6410	.20142	7.241	.8732

From table 6 it can be seen that the value obtained (t count) with the t table value. The t table value can be found in the t table with a significance value of 0.05 (2-sided test) with degrees of freedom (df) 22. In this study, the results for the t table are 2.074. While for the t count value can be seen in table 5 (t column) which is 5.744. The criterion for testing the hypothesis is the rejection value of H0. So, it can be concluded that there is a significant difference in student learning outcomes between the control class taught using the traditional learning model and the experimental class using the problem-based learning model. It can be seen from table 5 that the average value of student learning outcomes is 3.2192 which means it can improve student learning outcomes.

The findings of this study provide strong empirical evidence that the Problem-Based Learning (PBL) model significantly enhances both student learning activity and learning outcomes at the elementary school level. The descriptive analysis of learning activity (Table 4) indicates that students in the experimental class predominantly achieved good (72.7%) and very good (27.3%) activity categories, with no students classified as not good or not very good. In contrast, the control class was dominated by not good (63.6%) and not very good (27.3%) categories, reflecting limited student engagement under traditional instructional practices.

These results support the theoretical foundation of PBL, which is rooted in constructivist learning theory emphasizing active knowledge construction through authentic problem-solving experiences [34]-[39]. By engaging students in contextual problems, PBL encourages inquiry, discussion, collaboration, and reflection—key dimensions of learning activity that are often underdeveloped in teacher-centered classrooms. Lee et al [40] and Gomes et al [41] argue that behavioral and cognitive engagement are essential predictors of meaningful learning, and the activity patterns observed in the experimental class are consistent with this assertion. The higher mean learning activity score in the experimental class (M = 11) compared to the control class (M = 9), alongside higher minimum and maximum values, suggests that PBL not only increases overall participation but also reduces passive learning behaviors among lower-achieving students. Learning environments that promote active and constructive engagement yield superior learning processes compared to passive instructional approaches [42]-[46].

The inferential analysis further substantiates these findings. The independent samples t-test for learning activity (Table 5) yielded a t-value of 4.129, exceeding the critical value of 2.074 at the 0.05 significance level. This result confirms a statistically significant difference in learning activity between students exposed to PBL and those taught using traditional methods. Similar results have been reported in previous studies, which consistently demonstrate that PBL significantly enhances student engagement and classroom interaction across educational levels [47]-[50]. In addition to learning activity, the impact of PBL on learning outcomes is equally evident. The descriptive results in Table 5 show that 81.8% of students in the experimental class achieved the very good category, with a mean score of 85, while none fell into the moderate or not good categories. Conversely, the control class was dominated by moderate (63.6%) and good (27.3%) categories, with an average score of only 50. This substantial disparity indicates that PBL facilitates deeper conceptual understanding and more effective knowledge retention.

The statistical analysis of learning outcomes (Table 6) reinforces this conclusion. The obtained t-value of 5.744 far exceeds the critical t-table value (2.074), leading to the rejection of the null hypothesis and confirming a significant difference in learning outcomes between the two groups. This finding is consistent with prior meta-analyses demonstrating that PBL has a positive and significant effect on academic achievement, particularly when learning activities are aligned with real-world problems and guided inquiry [51], [52]. The superior learning outcomes observed in the experimental class can be attributed to the cognitive processes stimulated by PBL, such as problem analysis, hypothesis generation, evidence-based reasoning, and collaborative knowledge construction. According to Chaojing et al [53], these processes foster higher-order thinking skills and enable students to integrate new information more effectively into existing cognitive schemas. In contrast, traditional learning models tend to emphasize rote memorization and teacher-dominated explanations, which may limit students' opportunities for deep learning.

Overall, the findings indicate that traditional instructional models are insufficient in meeting students' needs for active participation and meaningful learning. The Problem-Based Learning model, by contrast, provides a contextualized, student-centered, and inquiry-oriented learning environment that simultaneously enhances learning activity and academic achievement. Given that learning activity is closely linked to learning outcomes, the dual improvement observed in this study underscores the pedagogical value of PBL for elementary education [54]. These results suggest that integrating PBL into elementary school instruction

represents a strategic approach to improving instructional quality, fostering active learning behaviors, and promoting sustainable academic achievement in line with 21st-century learning demands.

The novelty of this study lies in its empirical examination of the Problem-Based Learning (PBL) model in IPAS learning at the lower elementary school level (Grade III) within the specific context of Merdeka Curriculum implementation. Unlike previous studies that predominantly focus on higher grade levels, single disciplines, or general science subjects, this research integrates learning activity and learning outcomes simultaneously as outcome variables in an interdisciplinary IPAS framework. Furthermore, this study provides quantitative evidence demonstrating that PBL not only enhances cognitive achievement but also significantly strengthens students' active engagement in learning, which is a core demand of the Merdeka Curriculum. Thus, this research fills a contextual and methodological gap by positioning PBL as a practical and effective pedagogical solution for improving both process and outcome dimensions of learning in elementary education. The findings of this study have important theoretical, practical, and policy implications. Theoretically, the results reinforce constructivist learning theory by confirming that student-centered, problem-oriented learning environments significantly enhance learning activity and academic achievement. Practically, this study provides teachers with empirical evidence that the Problem-Based Learning model can be effectively implemented in elementary IPAS classrooms to increase student participation, critical thinking, and understanding of real-world problems. For educational policymakers and school administrators, the results support the alignment of instructional practices with the principles of the Merdeka Curriculum, emphasizing active learning, contextual problem-solving, and meaningful student engagement. Therefore, PBL can be considered a strategic instructional model to improve learning quality and support curriculum reform in primary education.

Despite its contributions, this study has several limitations. First, the sample size was relatively small and limited to one elementary school, which may restrict the generalizability of the findings to broader educational contexts. Second, the research design focused on posttest results, thus limiting the analysis of students' learning progress over time. Third, the study only examined learning activity and learning outcomes, without exploring other important variables such as critical thinking skills, motivation, or collaborative skills. Additionally, the duration of the intervention was relatively short, which may not fully capture the long-term impact of the Problem-Based Learning model. Based on the limitations and findings of this study, several recommendations are proposed. Future research should involve larger and more diverse samples across different schools and regions to enhance the generalizability of the results. Longitudinal studies are recommended to examine the long-term effects of Problem-Based Learning on student learning development. Further studies may also integrate additional variables such as problem-solving skills, creativity, motivation, or character development to provide a more comprehensive understanding of PBL's impact. Moreover, future research could explore the integration of PBL with digital learning tools or project-based learning to support differentiated instruction within the Merdeka Curriculum framework.

4. CONCLUSION

This study concludes that the implementation of the Problem-Based Learning (PBL) model has a significant positive effect on both learning activity and learning outcomes of elementary school students in IPAS learning. The findings demonstrate that students taught using the PBL model showed higher levels of active participation, engagement, and academic achievement compared to students who received traditional instruction. The statistical analysis using independent sample t-tests confirmed significant differences between the experimental and control groups in terms of learning activity and learning outcomes, indicating that the PBL model is more effective in promoting meaningful learning. The improvement in learning activity among students in the experimental class reflects the ability of the PBL model to create a student-centered learning environment that encourages inquiry, collaboration, and problem-solving through real-life contexts. Increased learning activity was found to be closely associated with better learning outcomes, suggesting that active engagement plays a crucial role in enhancing students' understanding and retention of learning materials. In contrast, traditional learning models that are teacher-centered tend to limit students' opportunities to actively construct knowledge, resulting in lower levels of engagement and achievement. Furthermore, this study provides empirical support for the relevance of the Problem-Based Learning model in the implementation of the Merdeka Curriculum at the elementary school level. By aligning with the principles of active learning, contextualization, and learner autonomy, PBL serves as an effective pedagogical approach to improve the quality of IPAS instruction. Therefore, it can be concluded that Problem-Based Learning is a viable and recommended instructional model for fostering active learning and improving academic outcomes in elementary schools, particularly within the framework of curriculum transformation toward student-centered education.

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AUTHOR CONTRIBUTIONS

The author was solely responsible for the conceptualization and design of the study, data collection, implementation of the narrative counseling intervention, data analysis, and interpretation of the results. The author also prepared the original draft of the manuscript, revised the content critically, and approved the final version for publication.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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