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The Influence of the Problem-Based Learning Model Assisted by 'Energy Exploration Board' Media on Scientific Literacy and Learning Outcomes in Elementary School Science and Social Studies (IPAS)

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ABSTRACT: The learning of Science and Social Sciences (IPAS) in elementary schools currently faces challenges, particularly in the low achievement of students' scientific literacy and learning outcomes. The learning process is often dominated by teacher-centered methods, lacking the integration of innovative media that fosters active student engagement. This research aims to examine the influence of the Problem-Based Learning (PBL) model supported by "Papan Jelajah Energi" (Energy Exploration Board) media on students' scientific literacy and learning outcomes. The study employed a quasi-experimental design with a Pretest-Posttest Control Group Design involving 5th-grade students at SDN Kandangtepus 02. The research instruments included scientific literacy tests and cognitive learning outcome tests. Data analysis was conducted using the independent samples t-test. The results showed that the experimental group, which implemented the PBL model with the Papan Jelajah Energi media, achieved significantly higher scores compared to the control group. This indicates that the integration of PBL and interactive game-based media is effective in improving students' understanding of renewable energy concepts and their scientific literacy skills.

KEYWORDS: Learning Outcomes, Problem Based Learning, Papan Jelajah Energi, Scientific Literacy, IPAS.

INTRODUCTION

Education functions as a vehicle for unearthing and honing students' potential. Its purpose is to equip them with the intellect and practical skills necessary to adapt and contribute actively to society. Amidst efforts to enhance the quality of education, scientific literacy has become a primary focus. Data from PISA 2022 reveals that the scientific capabilities of Indonesian students remain lagging, with a score of 383. This fact serves as a serious wake-up call to evaluate teaching methods, particularly in Natural and Social Sciences (IPAS) subjects at the elementary school level. Content-oriented and rote-memorization learning models should shift toward models that train students to think analytically, reason, and adopt a scientific attitude in decision-making.

Scientific literacy is defined as the competence to apply scientific insight, pose investigative questions, and generate conclusions supported by empirical facts (Nugraha, 2022). According to the OECD (2018), aspects of scientific literacy include knowledge, processes, applications, and attitudes toward science. Furthermore, TIMSS (IEA, 2023) emphasizes that scientific literacy comprises the ability to think logically, reason, and conduct simple scientific practices to make decisions with a tangible impact on daily life.

Learning outcomes are defined as relatively permanent modifications of student behavior resulting from the learning process. This achievement integrates three primary dimensions: cognitive, affective, and psychomotor (Sujana, 2021; Sudjana, 2019). Dakhi (2020) asserts that learning outcomes also constitute students' academic achievements, as evidenced by exams, assignments, and active participation in the learning process.

Realities in the field indicate that student scientific literacy levels remain suboptimal, falling within the moderate to low categories. This low achievement is exacerbated by the dominance of conventional, one-way (teacher-centered), and monotonous teaching methods, which hinder student motivation and comprehension of abstract scientific concepts. As a strategic solution, the implementation of innovative learning models such as Problem-Based Learning (PBL) becomes a priority step. PBL provides students with exposure to contextual problems, capable of stimulating investigative skills and critical thinking.

Problem-Based Learning (PBL) is a constructivism-based learning model that is student-centered, where students are confronted with real or simulated problems to be solved through investigation (Mayasari, 2022). The hallmarks of PBL include

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students taking control of the learning process, the use of authentic problems, group collaboration, and the teacher's role as a facilitator.

According to Arends (2012), the steps of PBL consist of five phases: (1) orienting students to the problem, (2) organizing students to learn, (3) guiding individual and group investigations, (4) developing and presenting artifacts, and (5) analyzing and evaluating the problem-solving process. Its strengths are proven to increase critical thinking skills (Yuliasandra & Wulandari, 2023), learning motivation (Ekayanti, 2021), as well as higher-order cognitive learning outcomes (Walker & Leary, 2023).

Learning effectiveness depends not only on the choice of model but also on the importance of using engaging supporting media. This research integrates the Problem-Based Learning (PBL) model with the 'Energy Exploration Board' (Papan Jelajah Energi) media. The Energy Exploration Board is a learning medium in the form of an educational game resembling an interactive board game, such as Snakes and Ladders, which highlights the theme of renewable natural resources and is equipped with digital QR code features.

The characteristics of this medium are "learning while playing," being contextual, and collaborative, designed to foster understanding and an attitude of environmental care. According to Astiti et al. (2024), the main advantage of board game media is the ability to visualize abstract concepts into concrete ones, serving as enjoyable visual scaffolding. This is effective in optimizing the implementation of PBL, thereby increasing scientific literacy and student learning outcomes.

METHOD RESEARCH

The approach employed in this study is quantitative, utilizing a quasi-experimental research design. The specific design applied is the Non-equivalent Control Group Design. The research was conducted at SD Negeri Kandangtepus 02, Senduro District. The population comprised all fifth-grade students, with the sample divided into two groups: Class 5A served as the control group employing cooperative learning, while Class 5B served as the experimental group utilizing the Problem-Based Learning (PBL) model assisted by the 'Energy Exploration Board' (*Papan Jelajah Energi*) media.

Data collection was carried out using scientific literacy test instruments covering content, process, and context aspects, as well as cognitive learning outcome tests ranging from levels C1 to C4. The feasibility of the instruments was established through validity testing specifically content, construct, and empirical validity—as well as reliability testing. For data analysis, the study utilized SPSS 27.0 software, beginning with normality tests and followed by hypothesis testing using the Independent Sample T-test.

RESULTS

The objective of this study is to examine the effectiveness of implementing the Problem-Based Learning (PBL) model, supported by the 'Energy Exploration Board' (*Papan Jelajah Energi*) media, on the enhancement of students' scientific literacy and learning outcomes. Data collection was conducted using a pretest and posttest mechanism across two sample groups: the experimental class, which received the media-assisted PBL intervention, and the control class, which utilized a cooperative learning model.

Descriptive analysis results indicate an increase in average scores for both groups. However, the experimental class recorded a significantly higher improvement compared to the control class. A comparison of the average pretest and posttest scores is presented in Table 1 below.

Table 1. Comparison of Scientific Literacy Scores

Statistical Data	Pretest (Experiment)	Pretest (Control)	Posttest (Experiment)	Posttest (Control)
Highest Score	50	50	100	90
Lowest Score	10	30	60	60
Mean	30	42	83	74

Based on Table 1, regarding the Scientific Literacy variable, the experimental class experienced a score increase of 50 points (from 30 to 83)[^1], whereas the control class increased by only 43 points (from 31 to 74). For the learning outcomes variable, the experimental class improved drastically by 50 points (from 36 to 86), significantly higher compared to the control class, which increased by only 24 points (from 39 to 63).

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Table 2 below presents the comparison of learning outcome scores at the pretest and posttest stages.

Table 2. Comparison of Learning Outcome Scores

Statistical Data	Pretest (Experiment)	Pretest (Control)	Posttest (Experiment)	Posttest (Control)
Highest Score	55	50	95	70
Lowest Score	25	25	75	60
Mean	36	39	86	63

The data indicates that although both groups commenced with relatively comparable averages (36 and 39), a significant difference in improvement emerged in the final results (posttest), where the experimental class achieved a much higher average compared to the control class.

Analysis of the learning outcome data demonstrates a significantly more pronounced impact of the intervention on the experimental class compared to the control class. Although the control class possessed a slightly higher initial score, the experimental class experienced a substantial surge in improvement, with the posttest average reaching 86 (an increase of 50 points), whereas the control class only reached an average of 63 (an increase of 24 points).

1. Analysis of the Effect of the Problem-Based Learning Model Assisted by the 'Energy Exploration Board' on Scientific Literacy

The initial step before conducting the independent sample t-test is to verify the assumption of normal distribution via a normality test, which is a fundamental prerequisite in parametric statistical analysis. This testing was performed utilizing SPSS version 27.0 software using the Shapiro-Wilk method. The specific results regarding the difference between pretest and posttest scores for scientific literacy capabilities are presented in Table 3 below:

Table 3. Normality Test for Scientific Literacy Capabilities

	Shapiro-Wilk		
	Statistic	df	Sig.
Control Class	.930	17	.219
Experimental Class	.944	17	.368

The results of the Shapiro–Wilk test indicate that both groups, the control class and the experimental class, exhibit significance values (Sig.) greater than 0.05. The control class obtained a Sig. value of 0.219, while the experimental class yielded a Sig. value of 0.368. A significance value exceeding 0.05 indicates that the scientific literacy data for both groups follow a normal distribution pattern, implying that no significant difference was observed between the sample data distribution and the theoretical normal distribution.

The Independent Sample T-test aims to determine the difference in means between two unpaired sample groups: the experimental class and the control class. This test was administered after confirming that the data satisfied the normality assumption, thereby ensuring a precise and valid analysis. The results of the Independent Sample T-test for scientific literacy are presented below:

Table 4. Independent Sample T-Test Results for Scientific Literacy

		Levene's Test Equality of variance		**t-test for Equality of Means**			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Scientific literacy	Equal variance assumed	5.212	.029	-3.455	32	.002	-20.58824
	Equal variance not asssumed			-3.455	23.418	.002	-20.58824

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The scientific literacy achievement of students in the control class was proven to be lower than those in the experimental class. This is further supported by the confidence interval range, which indicates that the difference is a real and consistent result. Overall, it can be concluded that the instructional intervention in the experimental class had a significant positive impact on improving students' scientific literacy.

2. Analysis of the Effect of the Problem-Based Learning Model Assisted by 'Energy Exploration Board' Media on Learning Outcomes

A normality test was conducted to examine whether the posttest data from the Control Class and the Experimental Class were normally distributed. Satisfying this assumption is crucial to ensure the statistical validity of the hypothesis testing results.

Table 4.6. Normality Test of Learning Outcomes

	Shapiro-Wilk		
	Statistic	df	Sig.
Control Class	.924	17	.170
Experimental Class	.943	17	.355

The results of the normality test using the Shapiro–Wilk technique indicate that the learning outcome data for both groups exhibit a normal distribution. This is confirmed by significance values (Sig.) exceeding 0.05, with the control class obtaining a value of 0.170 and the experimental class 0.355. The fulfillment of the normality assumption serves as the basis for employing parametric statistical analysis, specifically the Independent Samples T-test.

The assessment of the treatment's effectiveness in the experimental group was conducted measurably through statistical analysis, serving as an empirical foundation for determining inter-group differences for hypothesis testing. The data from the Independent Sample T-test is presented in Table 4.7 below.

Table 4.7. Independent Sample T-Test of Learning Outcomes

		Levene's Test of Equality variance		**t-test for Equality of Means**			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Scientific literacy	Equal variance assumed	.749	.393	-7.952	32	<.001	-25.00000
	Equal variance not asssumed			-7.952	29.968	<.001	-25.00000

The Independent Samples T-Test was used to compare the mean learning outcomes between the control and experimental classes. Based on the prerequisite tests, the variances of both groups were found to be homogeneous; thus, the analysis was conducted assuming equal variances. The results indicate a significant difference in mean learning outcomes between the two groups. Specifically, the average student learning outcome in the control class was proven to be lower than that of the experimental class. The consistency of this difference is further reinforced by the confidence intervals, which demonstrate that these results are a real impact of the instructional intervention provided and did not occur by chance.

DISCUSSION

Based on the hypothesis testing results, the implementation of the Problem-Based Learning (PBL) model assisted by the 'Energy Exploration Board' (*Papan Jelajah Energi*) media was proven to exert a significant and superior influence on the enhancement of both scientific literacy and student cognitive learning outcomes compared to the control class. The superiority of the experimental class is attributed to the synergy between the learning model and the media, detailed as follows:

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- The 'Energy Exploration Board' media functions as *visual scaffolding*, assisting students in visualizing abstract energy concepts into concrete forms. This facilitates the reconstruction of understanding, transforming students' limited comprehension into a much deeper scientific understanding.
- The Problem-Based Learning model shifts learning patterns from passive to active. Students are engaged in constructing meaningful understanding through problem identification, data interpretation, and discussion. This process builds a robust knowledge structure that is applicable in real-world situations.
- Students construct their own knowledge through direct experience, resulting in sustainable mastery of the material. These findings are consistent with prior research (Erayani & Jampel, 2022; Artini, 2025; Khadijah et al., 2025; Fauzi et al., 2024), which confirms that the integration of PBL with interactive media effectively bridges theory with real-life reality, while also enhancing motivation and problem-solving abilities.

CONCLUSION

The implementation of the Problem-Based Learning (PBL) model among 5th-grade students at SD Negeri Kandangtepus 02, Senduro District, demonstrates that Problem-Based Learning, assisted by the *Papan Jelajah Energi* (Energy Exploration Board) media, has a significant impact on scientific literacy and learning outcomes regarding renewable energy in the Natural and Social Sciences (IPAS) subject.

These findings indicate that integrating Problem-Based Learning with innovative learning media can optimize student engagement and enhance their conceptual understanding in greater depth. Overall, this learning model has proven effective in reinforcing a student-centered learning orientation particularly in developing scientific literacy and achieving learning outcomes—thereby aligning with the principles and educational direction of the *Kurikulum Merdeka* (Merdeka Curriculum).

SUGGESTIONS

Teachers are encouraged to continue developing the implementation of the Problem-Based Learning model integrated with innovative media, such as the *Papan Jelajah Energi Hijau* (Green Energy Exploration Board). This approach reinforces meaningful learning while assisting students in constructing understanding through active learning experiences.

Furthermore, schools need to support various innovative learning initiatives by providing adequate infrastructure and facilities, as well as facilitating teacher professional development, ensuring that curriculum implementation remains contextual and aligned with student needs. Additionally, future researchers are encouraged to further develop the *Papan Jelajah Energi* media by exploring more diverse scopes, variables, and instructional designs to enhance the overall quality of learning.

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