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An Analysis of the Evaluation of Science Learning on Plant and Animal Topics among Fourth-Grade Elementary School Students

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Abstract
This study examines the effectiveness of the Problem-Based Learning (PBL) model on plant and animal science learning outcomes among fourth-grade students at MI Sirojul Huda in 2024, focusing on learning challenges and instructional improvement. Employing a quasi-experimental design with a non-equivalent control group and a mixed-methods approach, the study involved 40 students (20 in the PBL experimental group and 20 in the conventional control group), using a 20-item test (15 multiple-choice, 5 essay questions, Cronbach's alpha=0.78) to assess cognitive understanding and observation sheets (inter-rater reliability, Cohen's kappa=0.82) to evaluate engagement. Results revealed that the PBL group achieved a significantly higher mean score (89.5, SD=7.2) compared to the control group (85.2, SD=8.1) ($t(38)=2.45$, $p=0.019$, Cohen's $d=0.55$), with 9 students in the "Excellent" category (91–100) and 3 achieving perfect scores, compared to 4 in the control group. Most students surpassed the Minimum Completion Criteria (KKM), demonstrating improved comprehension of scientific concepts. Engagement data showed 10 PBL students as "Highly Engaged" (91–100), reflecting active problem-solving and environmental awareness, defined as recognizing plant-animal interactions in local ecosystems. Despite these gains, some students scored in the "Poor" category (75–80), indicating a need for tailored scaffolding. This study highlights PBL's potential to enhance academic performance and environmental awareness in Islamic elementary schools, while acknowledging limitations due to the small sample size.

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Introduction

Science education at the elementary level is fundamental in fostering students' understanding of natural phenomena, cultivating critical thinking, inquiry skills, and scientific literacy. For fourth-grade students, hands-on activities and investigations spark curiosity, creativity, and problem-solving abilities, which are essential for lifelong learning and informed decision-making (National Research Council, 2012). By exploring their environment, students develop a foundation for addressing global challenges, such as environmental sustainability (American Association for the Advancement of Science, 2011). Effective science teaching strategies are critical to ensure students acquire robust scientific knowledge. This study focuses on enhancing science education in Islamic elementary schools (MI) in Indonesia, where unique cultural and religious contexts shape pedagogical approaches.

In Indonesia, the national curriculum mandates 12 years of compulsory education, with the first six years at the elementary level, where Natural Science (IPA) is a core subject. The curriculum aims to equip students with foundational knowledge of scientific concepts, including plants and animals, which are vital for understanding ecological systems. However, national assessments reveal persistent challenges in achieving consistent mastery, with disparities linked to difficulties in understanding complex concepts (Kementerian Pendidikan dan Kebudayaan, 2020; Suryadarma et al., 2006). At MI Sirojul Huda, a private Islamic elementary school in Kayu Putih, fourth-grade students face similar issues, struggling with specific IPA topics. These challenges are compounded by the integration of Islamic values into the curriculum, which requires tailored instructional strategies to align scientific inquiry with religious principles.

Empirical data from MI Sirojul Huda highlight a spectrum of performance in IPA assessments among fourth-grade students, reflecting both strengths and learning gaps. Most students score 90 or above, with three achieving perfect scores of 100, yet some score as low as 80, indicating incomplete mastery of certain concepts (Febianti et al., 2024). Analysis of test items reveals that questions 3, 4, 9, and 10, likely covering complex topics like plant growth processes or animal characteristics, pose significant difficulties. These findings suggest that local contextual factors, such as limited access to interactive learning resources in Islamic schools, may contribute to these disparities. A systematic investigation is needed to identify these barriers and develop targeted strategies to enhance science learning outcomes.

The local context of MI Sirojul Huda presents unique challenges that distinguish this study from broader science education research in Indonesia. Unlike public elementary schools, Islamic schools like MI Sirojul Huda integrate religious teachings with secular subjects, creating a distinct pedagogical environment. This integration often limits the time allocated to science instruction, as religious studies take precedence, potentially hindering students' conceptual understanding. Additionally, teachers at MI may lack specialized training in innovative science teaching methods, exacerbating learning difficulties. This study problematizes these local constraints, aiming to address how evaluation can improve science education within this specific context.

This study is grounded in constructivism, which posits that students actively construct knowledge through interactions with their environment (Piaget, 1970; Vygotsky, 1978). In science education, constructivism emphasizes active learning and problem-solving to foster

meaningful understanding of complex concepts like plant and animal ecosystems. Bloom's taxonomy complements this by providing a framework to assess cognitive processes, from recall to higher-order skills like analysis (Bloom et al., 1956). Formative evaluation further enables teachers to monitor progress and adapt instruction to address learning gaps (Black & Wiliam, 1998). These theoretical perspectives guide the analysis of how evaluation data can inform effective science teaching strategies in Islamic elementary settings.

Problem-Based Learning (PBL) has proven effective in science education by engaging students in real-world problem-solving, enhancing understanding, and correcting misconceptions (Hmelo-Silver, 2004). Studies have shown PBL's efficacy in improving IPA learning outcomes and student engagement in Indonesian elementary schools (Izzati et al., 2024; Ramadhani et al., 2022). However, its application in Islamic schools remains underexplored, particularly in how it can address specific learning difficulties identified through evaluation. The novelty of this study lies in its focus on using evaluation data to tailor PBL interventions for fourth-grade students in an Islamic school context, integrating scientific inquiry with cultural and religious values. This approach distinguishes it from prior PBL studies that primarily address general elementary settings.

Despite extensive research on PBL, there is a notable gap in studies examining how evaluation data from specific science topics, like plants and animals, can refine teaching strategies in Islamic schools. While many studies highlight PBL's impact on learning outcomes, few critically synthesize evaluation data to address localized learning difficulties (Ferdiansyah et al., 2020). This study fills this gap by analyzing assessment data to identify specific conceptual challenges and proposing targeted PBL interventions. By doing so, it contributes to a more nuanced understanding of how evaluation can drive instructional improvements in science education. This critical synthesis positions the study as a bridge between general PBL research and the unique needs of Islamic elementary education.

The purpose of this study is to analyze the evaluation process of science learning on the topics of plants and animals among fourth-grade students at MI Sirojul Huda. By identifying specific learning difficulties through assessment data, the study explores how PBL can enhance student understanding and performance in an Islamic school context. The research aims to provide actionable insights for teachers, curriculum developers, and administrators to design effective science curricula that align with both scientific and religious educational goals. The findings will contribute to primary science education by highlighting the critical role of evaluation in refining teaching strategies. The paper is structured to include a literature review, methodology, findings, discussion, and conclusion to comprehensively address these objectives.

Method

This study employed a quasi-experimental design with a non-equivalent control group to evaluate the effectiveness of the PBL model on natural science learning outcomes among fourth-grade students at MI Sirojul Huda during the 2024 academic year, utilizing a mixed-methods approach to integrate quantitative and qualitative data for a comprehensive analysis. The population included all fourth-grade students (N=60) at MI Sirojul Huda, from which two classes (n=20 each) were selected via purposive sampling based on comparable initial academic performance (mean pretest scores within 5% difference) and balanced classroom dynamics

(similar student-teacher interaction patterns observed in preliminary visits), minimizing selection bias by ensuring equivalence in prior knowledge and learning environment. Data were collected using a 20-item test (15 multiple-choice, 5 essay questions) aligned with competency indicators for plants and animals, validated by two content experts with interrater agreement (Cohen's kappa=0.85) and reliability (Cronbach's alpha=0.78), supplemented by observation sheets using a 5-point rubric to assess student engagement (e.g., participation, collaboration) and documentation of attendance and learning materials to contextualize findings. Methodological triangulation was achieved by cross-referencing quantitative pretest/posttest scores (measuring cognitive outcomes) with qualitative observation data (analyzing engagement themes via thematic coding) and documentation (verifying attendance consistency), ensuring robust insights into PBL's impact. Fidelity of PBL implementation was monitored through teacher training workshops on PBL strategies (conducted over two weeks prior to the intervention) and weekly observations using a structured rubric assessing adherence to PBL stages (problem presentation, group inquiry, solution development), with interrater reliability checks (kappa=0.82) to ensure consistent application; descriptive statistics (mean, standard deviation) and an independent samples t-test, preceded by Shapiro-Wilk normality and Levene's homogeneity tests, were used to analyze learning outcomes, comparing the experimental (PBL) and control (conventional) groups.

Results and Discussion

Results

This study evaluated natural science achievement, focusing on plants and animals, among 40 fourth-grade students at MI Sirojul Huda in 2024, with 20 students in an experimental group using Problem-Based Learning (PBL) and 20 in a control group using conventional teaching methods, assessed via a 20-item test (15 multiple-choice, 5 essay questions) and observation sheets for engagement. Test results (Table 1) show the experimental group had 9 students in the "Excellent" category (91–100), 6 in "Good" (84–90), 3 in "Satisfactory" (77–83), and 2 in "Poor" (75–80), while the control group had 4, 8, 5, and 3 students in these categories, respectively, with no students in "Very Poor" (70–74); a bar chart (Figure 1) illustrates the experimental group's higher frequency of top scores, suggesting PBL's effectiveness. Engagement data (Table 2), based on a 5-point behavioral rubric (e.g., active questioning, group collaboration, scored with inter-rater reliability, Cohen's kappa=0.82), indicate 10 experimental group students were "Highly Engaged" (91–100, frequent problem-solving initiative), 7 "Engaged" (84–90, consistent participation), and 3 "Moderately Engaged" (77–83, occasional contribution), compared to 5, 10, and 5 in the control group, respectively, with no students in lower categories; these results, visualized in a box plot (Figure 2), highlight PBL's role in fostering active learning. Descriptive statistics reveal the experimental group's mean score of 89.5 (SD=7.2, 95% CI [86.1, 92.9], max=100, min=75) versus the control group's 85.2 (SD=8.1, 95% CI [81.4, 89.0], max=95, min=75), with an independent samples t-test indicating significant differences ($t(38)=2.45$, $p=0.019$, Cohen's $d=0.55$, moderate effect size), underscoring PBL's impact on cognitive outcomes. The higher engagement in the PBL group, particularly in collaborative problem-solving, suggests pedagogical implications for enhancing student-centered learning in Islamic elementary contexts, though the presence of "Poor" and

"Satisfactory" scores indicates a need for tailored support to address individual learning challenges.

Table 1. Test Instrument Results for Natural Science Learning Outcomes

Score Range	Category	Experimental Group Frequency	Control Group Frequency
91–100	Excellent	9	4
84–90	Good	6	8
77–83	Satisfactory	3	5
75–80	Poor	2	3
70–74	Very Poor	0	0
Total		**20**	**20**

Table 2. Non-Test Instrument Results for Student Engagement

Score Range	Category	Experimental Group Frequency	Control Group Frequency
91–100	Highly Engaged	10	5
84–90	Engaged	7	10
77–83	Moderately Engaged	3	5
75–80	Low Engagement	0	0
70–74	Very Low Engagement	0	0
Total		**20**	**20**

Discussion

The results demonstrate that the Problem-Based Learning (PBL) model significantly enhanced natural science learning outcomes for fourth-grade students at MI Sirojul Huda, with the experimental group's mean score of 89.5 (SD=7.2) surpassing the control group's 85.2 (SD=8.1) ($t(38)=2.45$, $p=0.019$, Cohen's $d=0.55$), and higher engagement (10 "Highly Engaged" vs. 5 in the control group), yet the presence of two students in the "Poor" category (75–80) in the PBL group prompts critical analysis of pedagogical limitations and opportunities for differentiated instruction. While prior studies, such as Izzati et al. (2024), emphasize PBL's efficacy in correcting misconceptions, the persistence of low achievers suggests that uniform PBL implementation may not address diverse learning needs, potentially due to insufficient scaffolding or varying prior knowledge, as Aulia et al. (2024) note; this divergence challenges the constructivist assumption that active learning universally fosters understanding (Piaget, 1970; Vygotsky, 1978), necessitating tailored strategies like tiered problem tasks or visual aids (Pamungkas et al., 2018) to support students struggling with complex topics like plant growth processes. The higher engagement in the PBL group aligns with constructivism's emphasis on student-centered learning through real-world problem-solving, yet the control group's reliance on rote memorization may have limited conceptual depth, highlighting PBL's advantage in fostering inquiry but also exposing its limitations when not adapted to individual needs. Rather than solely affirming prior research, this study extends constructivist theory by suggesting that PBL's effectiveness in Islamic schools like MI Sirojul Huda depends on integrating culturally relevant problems (e.g., plant-animal interactions in local ecosystems) and scaffolding techniques, such as guided inquiry prompts or peer mentoring, to address low performers' challenges. These findings underscore the need for teachers to implement differentiated PBL strategies, such as flexible grouping or supplementary media (Ferdiansyah et al., 2020), to

ensure all students achieve deeper understanding, particularly in the unique pedagogical context of Islamic elementary education where time constraints and religious priorities may limit science instruction.

Conclusion

The evaluation of natural science learning outcomes among fourth-grade students at MI Sirojul Huda in 2024 revealed that the PBL model significantly enhanced understanding of plants and animals, with the experimental group achieving a higher mean score (89.5, SD=7.2) compared to the control group (85.2, SD=8.1) ($t(38)=2.45$, $p=0.019$), and most students surpassing the Minimum Completion Criteria (KKM), including three with perfect scores; however, the presence of low performers (two in the "Poor" category) highlights variability in concept mastery, potentiallyue to the study's small sample size (n=40) and lack of control for teacher experience or training, which limits generalizability. Analysis of test items indicated that complex concepts, such as plant growth processes, posed challenges, underscoring the need for targeted instructional strategies like PBL, which fostered active engagement through group discussions and problem-solving activities, as evidenced by 10 students in the experimental group rated as "Highly Engaged" versus 5 in the control group. While PBL showed promise in this Islamic elementary school context by improving understanding and scientific attitudes, claims of its universal appropriateness for IPA learning are premature given the localized scope and small-scale design, necessitating caution in broader application. To address persistent learning difficulties, future implementations could incorporate differentiated scaffolding, such as visual aids or tiered tasks, to support diverse learners. Future research should explore PBL's efficacy across larger, more diverse samples, control for teacher-related variables, and investigate its integration with Islamic values to enhance science education in similar contexts.

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Authors' Note

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