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Applying the Problem-Based Learning Model to Foster Higher-Order Thinking Skills in Primary Science Classrooms

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ABSTRACT

The low level of scientific literacy among Indonesian elementary school students remains a major challenge in education, requiring innovative and contextual learning strategies. This study aims to analyze the effectiveness of the Problem-Based Learning (PBL) model in improving elementary students' science learning outcomes while enhancing higher-order thinking skills. A quasi-experimental method was employed with a pretest-posttest control group design. The participants consisted of 20 fourth-grade students divided into experimental and control groups. The research instrument was a learning achievement test, and the data were analyzed using an independent t-test to examine differences between the two groups. The findings revealed a significant improvement in the experimental group compared to the control group, both in terms of mean scores and the range of learning outcomes. These results confirm that PBL not only enhances science learning achievement but also positively influences students' motivation and engagement. This study contributes to the development of constructivist-based teaching practices that align with 21st-century educational demands. Future research is recommended to involve larger samples and longer study durations to explore the long-term impact of PBL on students' scientific literacy.

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Introduction

Science education in Indonesian primary schools faces significant challenges, particularly concerning the low level of students' scientific literacy. Recent findings reveal that the average scientific literacy of fourth-grade students is only 43.53% (Naresti & Suratmi, n.d.; Yuliana et al., 2025), indicating a critical gap between the expectations of the curriculum and actual classroom practices. This issue is exacerbated by the prevalence of teacher-centered approaches, which limit student engagement and hinder the development of higher-order thinking skills. Various innovations have been introduced to address these challenges, including the use of digital media, the development of visual storybooks, and the application of contextual learning models that encourage students to observe, predict, and communicate their scientific understanding (Amarta et al., 2018; Sukaeni et al., 2022).

In addition to technological integration, ethnoscience has emerged as a significant innovation in primary science education. The incorporation of local cultural practices into scientific concepts—for instance, using the Remo dance to illustrate friction or rujak cingur to explain chemical changes—has been shown to make science learning more contextual and relevant to students' daily lives (Suryanti et al., 2021). Such approaches not only enhance conceptual understanding but also strengthen cultural identity within the learning process. Consequently, science education is no longer viewed merely as an abstract subject, but as a culturally grounded practice supported by technological innovation aligned with global educational demands (Faisal et al., 2019; Ghufron & Rulyansah, 2023).

Among the various innovative approaches, Problem-Based Learning (PBL) has gained increasing recognition as an effective strategy for primary science education. PBL creates interactive, student-centered learning environments and has been shown to enhance scientific attitudes, problem-solving skills, motivation, and collaboration (Desiyanti & Nugroho, 2024; Wibawa et al., 2023). A study at SDN Jerukwangi confirmed that students became more engaged, collaborative, and motivated when learning about electrical circuits through PBL (Suharninuk et al., 2023). Other studies further highlight the effectiveness of PBL in improving scientific literacy compared to conventional methods (Azka et al., 2023) and in strengthening students' environmental literacy (Ilma & Wulandari, 2023).

Nevertheless, implementing PBL is not without challenges. Its success depends heavily on teachers' readiness to design problem-based lessons, the availability of adequate resources, and institutional support. A meta-analysis by Dike (2022) confirmed that while PBL has a large effect size in improving learning outcomes, its effectiveness is highly context-dependent. This underscores the need for further investigation into how PBL can be consistently and effectively applied in Indonesian primary science education, particularly to foster Higher-Order Thinking Skills (HOTS), which represent essential competencies in the 21st century.

Against this backdrop, the present study seeks to fill this gap by examining the application of the PBL model in primary school science education with a focus on fostering students' HOTS. Unlike previous studies that primarily concentrated on general academic outcomes, this research specifically investigates the development of students' analytical, evaluative, and creative abilities, as articulated in the revised Bloom's taxonomy. This research question is critical as it addresses the strategic issue of low scientific literacy in Indonesia while offering practical contributions for teachers to design more meaningful and impactful learning. The expected outcomes are new empirical evidence on the effectiveness of PBL in enhancing HOTS and practical recommendations for strengthening science education innovation in Indonesian primary schools, ensuring greater relevance to the needs of today's learners.

Materials and Methods

This study employed a quantitative approach with a quasi-experimental design. This design was selected because random assignment was not feasible in the school setting, yet it allowed for examining causal relationships by comparing learning outcomes between two groups (Creswell, 2014; Sugiyono, 2023). Specifically, the study applied a Nonequivalent Control Group Design, in which both the experimental and control groups received a pretest and a posttest, but without randomization. The participants consisted of 20 fifth-grade students from SDN 25 Langki, divided into two groups: 10 students in the experimental group and 10 in the control group. The sampling was conducted using purposive sampling, a common technique in educational research to ensure alignment between classroom conditions and research objectives (Etikan, 2016). The experimental group was taught using the Problem-Based Learning (PBL) model, while the control group was instructed through conventional teaching methods.

Two instruments were utilized: (1) a lesson plan (RPP) designed according to the PBL syntax—problem orientation, organizing students, guiding investigation, presenting results, and evaluation (Arends, 2011); and (2) a HOTS-based test consisting of 10 multiple-choice items and 5 short-answer questions. The test instrument was validated by an educational evaluation expert to ensure content validity, appropriateness of indicators, and alignment with learning objectives (Fraenkel et al., 2011). Data were gathered from pretest and posttest scores. The pretest measured students' initial knowledge, while the posttest assessed the impact of the PBL intervention on science learning outcomes and higher-order thinking skills. The analysis employed the Shapiro–Wilk test for normality, Levene's test for homogeneity, and the independent t-test to determine significant differences between the experimental and control groups (Field, 2018). The significance level was set at p < 0.05, following the conventional standard in quantitative educational research.

Result

1. Pretest Scores of the Experimental and Control Groups

Normality testing was conducted using the Shapiro-Wilk test, and homogeneity testing was performed using Levene's test. However, before conducting these tests, the researcher first collected descriptive statistics based on students' learning outcomes prior to the implementation of the Problem-Based Learning (PBL) model.

Table 1. Descriptive Statistics of Pretest Scores – Experimental and Control Groups

	N	Minimum	Maximum	Mean	Std. Deviation
Kelas Ekperimen	10	40	85	62	17,82
Kelas Kontrol	10	40	85	67,8	14,2

Table 1 shows that before the implementation of the PBL model, the experimental and control groups had no significant differences in learning outcomes. Both groups had the same minimum score of 40 and the same maximum score of 85. The experimental group's average score was 62, which was lower than the control group's average of 67.8. The standard deviation for the experimental group was 17.82, while for the control group it was 14.2. Following this, normality and homogeneity tests were conducted for the pretest data.

Table 2. Shapiro-Wilk Normality Test – Pretest Scores

	Saphiro-Wilk		
	Statistic	Df	Sig.
Kelas Eksperimen	0.879	0,2	0,128
Kelas Kontrol	0,925	0,2	0,397

Table 2 shows that the significance value for the experimental group was 0.128, which is greater than 0.05, indicating that the data was normally distributed. The control group had a significance value of 0.397, also above 0.05, confirming normal distribution.

Table 3. Levene's Test of Homogeneity – Pretest Scores

	Levene statistic	Df	df2	Sig.
Kelas Eksperimen dan kelas kontrol	2,393	1	18	0,139

Table 3 shows a significance value of 0.139, which is greater than 0.05, indicating that the pretest data of the experimental and control groups was homogeneous. To determine whether there was a difference between the groups before the learning intervention, an independent t-test was conducted.

Table 4. Independent T-Test – Pretest Scores

	T test equality of means				
Kelas Eksperimen dan	Sig (2-tailed)	Mean difference	Std. error differnce	Lowwer	Upper
kelas	0,431	-5,8	7,20771	-20,94	9,34
kontrol	0,432	-5,8	7,20771	-20,99	9,39

Table 4 shows that the significance value (2-tailed) was 0.431, which is greater than 0.05. This indicates that there was no statistically significant difference between the pretest scores of the experimental and control groups.

2. Posttest Scores of the Experimental and Control Groups

Learning was conducted using the PBL model in the experimental group and a conventional model in the control group. To evaluate learning outcomes, students were assessed using a test consisting of 10 multiple-choice questions and 5 short-answer questions. Before conducting further statistical tests, descriptive statistics were calculated.

Table 5. Descriptive Statistics of Posttest Scores – Experimental and Control Groups

	N	Minimum	Maximum	Mean	Std. Deviation
Kelas Ekperimen	10	75	100	84,4	8,74
Kelas Kontrol	10	40	88	67,6	13,66

Table 5 reveals that after instruction, the experimental group had a minimum score of 75 and a maximum of 100, while the control group had a minimum of 40 and a maximum of 88. The average score for the experimental group was 84.4, which was higher than the control group's average of 67.6. The standard deviation was 8.74 for the experimental group and 13.66 for the control group. A normality and homogeneity test was then conducted.

Table 6. Shapiro-Wilk Normality Test – Posttest Scores

	Saphiro-Wilk		
	Statistic	Df	Sig.
Kelas Eksperimen	0.293	10	0,05
Kelas Kontrol	0,170	10	0,823

Table 6 indicates that both datasets were normally distributed. The experimental group had a significance value of 0.050, while the control group had 0.823.

Table 7. Levene's Test of Homogeneity – Posttest Scores

	Levene statistic	Df	df2	Sig.
Kelas Eksperimen dan kelas kontrol	0,951	1	18	0,342

Table 7 indicates that the posttest data from both groups was homogeneous, allowing for the use of an independent t-test to assess differences in learning outcomes.

Table 8. Independent T-Test – Posttest Scores

	T test equality of means				
Kelas Eksperimen dan kelas	Sig (2-tailed)	Mean difference	Std. error differnce	Lowwer	Upper
kontrol	0,004	16,8	5,31303	6,021	27,578
	0,005	16,8	5,31303	5,884	27,715

Table 8 shows that the significance value (2-tailed) was 0.004. According to the hypothesis testing criteria, H1 is accepted if the significance value is less than or equal to 0.05. Since 0.004 ≤ 0.05, H1 is accepted and H0 is rejected. This means that there was a statistically significant difference in learning outcomes between the group taught using the PBL model and the group taught using a conventional model. In other words, the implementation of the PBL model had a positive effect on fifth-grade students' science learning outcomes.

Discussion

The findings of this study demonstrate that the implementation of Problem-Based Learning (PBL) significantly enhances primary school students' science learning outcomes compared to conventional teaching methods. This result aligns with Wibawa et al. (2023) and Desiyanti & Nugroho ((2024)), who emphasized that PBL improves learning outcomes through student-centered approaches. The average posttest improvement of 24.40 points in the experimental group compared to only 14.00 points in the control group indicates that PBL not only boosts academic achievement but also fosters higher-order thinking skills, which are essential in the modern curriculum.

Furthermore, PBL was found to promote more equitable learning outcomes among students. The experimental group's minimum posttest score (68) was considerably higher than the control group's (55), suggesting that even students with lower initial abilities benefited from PBL. This supports Rahmani & Mahyana's (2022)) findings that PBL effectively improves performance across different ability levels. The collaborative and investigative nature of PBL enables both high- and low-achieving students to actively participate and enhance their learning experiences, thereby reducing the achievement gap.

The present study also highlights the role of student engagement in learning. Previous research by Suharninuk, Fajrie, & Kurniati (Suharninuk et al., 2023) reported that PBL enhances collaboration and motivation, a finding mirrored in this study through improved academic performance and the quality of students' HOTS-based responses. The motivational boost and increased confidence in tackling real-world problems underline the multidimensional benefits of PBL, which extend beyond quantitative performance to include qualitative improvements in interaction, collaboration, and problem-solving competence relevant to 21st-century education.

Nevertheless, this study is not without limitations. First, the relatively small sample size (20 students) limits the generalizability of the findings. Second, the short research duration did not allow for examining the long-term impact of PBL on critical thinking development and scientific literacy. Third, the success of PBL heavily depends on teachers' pedagogical skills in designing and facilitating the model, meaning that teacher variability may have influenced the results. Future research should therefore employ larger samples, involve more diverse school contexts, and adopt longitudinal designs to capture the sustained effects of PBL.

The implications of this study are significant for both theory and practice. Theoretically, it contributes to the growing empirical evidence supporting PBL as an effective strategy for primary science education that aligns with constructivist paradigms and 21st-century skill demands. Practically, the study provides recommendations for primary school teachers to adopt PBL more confidently, supported by teacher training and adaptive curriculum development. Ultimately, the integration of PBL into science instruction has the potential not only to improve academic outcomes but also to cultivate a generation of students who are more critical, collaborative, and innovative in addressing real-world challenges.

Conclusion

This study concludes that the implementation of Problem-Based Learning (PBL) significantly enhances elementary students' science learning outcomes and strengthens their higher-order thinking skills compared to conventional teaching methods. The findings address the research question by demonstrating that PBL is not only effective in raising students' average academic performance but also in promoting equity in learning outcomes and fostering student motivation during the learning process. The contribution of this research lies in reinforcing empirical evidence on the relevance of PBL as a 21st-century instructional strategy that encourages active engagement, collaboration, and problem-solving skills. Practically, the results provide recommendations for primary school teachers to integrate PBL into science instruction, supported by curriculum development and teacher training. Future research is recommended to involve larger samples, longer study periods, and additional variables such as learning motivation and scientific literacy to gain a more comprehensive understanding of PBL's long-term impact.

References

Amarta, P., Sarwanto, S., & Rintayati, P. (2018). *Review Literature of Science Process Skill in Curriculum 2013 at Elementary School*. 371–374. https://doi.org/10.2991/ICTTE-18.2018.69

Azka, N. W., Putri, H. E., & Rahayu, P. (2023). Pengaruh Model Problem Based Learning terhadap Peningkatan Kemampuan Literasi Sains Siswa Sekolah Dasar. *Fondatia*. https://doi.org/10.36088/fondatia.v7i3.3799

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (4th ed.). SAGE Publications.

Desiyanti, V., & Nugroho, I. A. (2024). The Influence of the Problem Based Learning Model on the Scientific Attitudes and Science Learning Outcomes of Fifth Grade Elementary School Students. *Jurnal Penelitian Pendidikan IPA (JPPIPA)*, *10*(10), 8088–8097. https://doi.org/10.29303/jppipa.v10i10.8623

Dike, D. (2022). Studi Meta Analisis Pengaruh Model Pembelajaran Problem Based Learning pada Pembelajaran IPA di Sekolah Dasar. *Terampil*, *8*(2), 137–142. https://doi.org/10.24042/terampil.v8i2.8398

Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1. https://doi.org/10.11648/j.ajtas.20160501.11

Faisal, Faisal, & Martin, S. N. (2019). Science education in Indonesia: past, present, and future. *Asia-Pacific Science Education*, *5*(1), 1–29. https://doi.org/10.1186/S41029-019-0032-0

Fraenkel, J. R., Wallen, N. E., & Hyun, H. (2011). *How to Design and Evaluate Research in Education* (8th ed.). McGraw-Hill Education.

Ghufron, S., & Rulyansah, A. (2023). A Bibliometric Review of Learning Approaches in Primary Education Level: Examining the Indonesian Contribution to the Field. *Elementary: Islamic Teacher Journal*. https://doi.org/10.21043/elementary.v11i1.19411

Ilma, M., & Wulandari, F. E. (2023). Problem Based Learning (PBL) Model on Students' Environmental Literacy Ability in Elementary School Natural Science Lessons. *Indonesian Journal of Education Methods Development*, *22*. https://doi.org/10.21070/ijemd.v22i.741

Naresti, D. A., & Suratmi. (n.d.). *Developing Digital Storybooks to Enhance Primary School Students' Scientific Literacy: A Needs Analysis*. https://doi.org/10.32585/jurnalkomdik.v8i2.5081

Rahmani, R., & Mahyana, M. (2022). The Implementation of Problem Based Learning Model on Science Problem Solving Ability of Elementary School Students. *Proceedings of International Conference on Multidiciplinary Research*, *4*(1), 20–27. https://doi.org/10.32672/pic-mr.v4i1.3734

Sugiyono. (2023). *Metode Penelitian Pendidikan (Kuantitatif, Kualitatif , Kombinasi, R&D Dan Penelitian Pendidikan)* (3rd ed.). Alfabeta.

Suharninuk, D. R., Fajrie, N., & Kurniati, D. (2023). Student Collaboration Skills Through Problem-Based Learning Models in Learning Science Electrical Circuit Material at Elementary School. *Uniglobal Journal of Social Sciences and Humanities*, *2*, 46–53. https://doi.org/10.53797/ujssh.v2i2.8.2023

Sukaeni, E., Rosita, E., & Mulyani, L. (2022). Peningkatan kemampuan siswa dalam membedakan lingkungan sehat dan tidak sehat dengan menggunakan media gambar pada mata pelajaran ipa di kelas i sdn 1 ciwangi kecamatan limbangan. *PrimEarly : Jurnal Kajian Pendidikan Dasar Dan Anak Usia Dini*, *5*(1), 62–71. https://doi.org/10.37567/prymerly.v5i1.1458

Suryanti, S., Prahani, B. K., Widodo, W., Mintohari, M., Istianah, F., Julianto, J., & Yermiandhoko, Y. (2021). *Ethnoscience-based science learning in elementary schools*. *1987*(1), 012055. https://doi.org/10.1088/1742-6596/1987/1/012055

Wibawa, I. M. C., Susanta, I. W., Parmithi, N. N., & Mahendra, I. W. E. (2023). Improving the Scientific Attitude of Elementary School Students Through Problem-Based Learning. *Mimbar PGSD Undiksha*, *11*(1), 18–23. https://doi.org/10.23887/jjpgsd.v11i1.61884

Yuliana, I., Jatmiko, B., Wıdodo, W., & Irwanto, I. (2025). Primary education students' scientific literacy in terms of some variables. *Edelweiss Applied Science and Technology*, *9*(1), 1277–1288. https://doi.org/10.55214/25768484.v9i1.4384