

Problem-based learning in science education: A systematic review of its effectiveness and research trends in Indonesia

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Abstract

Science education continues to face persistent challenges, including low learning outcomes and students' underdeveloped critical thinking skills. While Problem-Based Learning (PBL) has been widely recommended as a pedagogical solution, comprehensive reviews synthesizing its research trends and effectiveness within the Indonesian national context remain scarce. This study aims to analyze the trends, methodological approaches, and reported impacts of PBL implementation in science education. Employing a literature review design, data were collected from 15 SINTA-indexed national articles published between 2020 and 2024. The articles were analyzed through content analysis to identify patterns in educational levels, research designs, supporting media, and learning outcomes. The findings reveal that PBL is predominantly applied at the elementary school level, with Classroom Action Research (CAR) being the most frequently employed methodology. All reviewed studies reported positive impacts of PBL on students' learning outcomes, conceptual understanding, and critical thinking skills, with varying degrees of improvement observed across specific instructional cycles. Furthermore, the integration of supporting media such as audio-visual materials, dioramas, and e-comics was found to significantly enhance PBL's effectiveness. These findings provide a roadmap for future PBL research, particularly by encouraging exploration at higher education levels, enriching science topics that have received little attention, and integrating innovative media based on local wisdom to meet the demands of 21st-century scientific literacy.

Keywords: Problem based learning; Science education; Learning outcomes; Literature review; Indonesia

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INTRODUCTION

Natural science is a broad and fundamental human endeavor, the essence of which can be defined from various perspectives. In general, it encompasses disciplines such as physics, chemistry, biology, and earth sciences, each of which may employ different approaches to examine reality. Fundamentally, natural science is the study of the natural world aimed at understanding it and generating new knowledge that not only enables the prediction of phenomena but also allows for the application of that knowledge in daily life (Chiapetta et al.,

1998). Furthermore, natural science is viewed as a system of knowledge regarding the universe, derived from data gathered through controlled observations and experiments. The validity of a theory in natural science is tested against three key criteria: (1) its ability to explain observed phenomena, (2) its ability to predict unobserved phenomena, and (3) its susceptibility to further experimental testing and modification in light of new data (Carin & Sund, 1989).

These three aspects reflect the core elements of Natural Science (IPA): process (method), product, and scientific attitude. The scientific process or method refers to specific ways of investigating problems and making observations such as formulating hypotheses, designing and conducting experiments, evaluating data, and taking measurements. Scientific products consist of facts, principles, laws, and theories resulting from this process; an example is the principle that metals expand when heated. Meanwhile, scientific attitude encompasses the beliefs, values, and perspectives that scientists should possess, for instance, the willingness to withhold judgment until sufficient data has been gathered (Carin & Sund, 1989). Thus, Natural Science education goes beyond the rote memorization of concepts; it equips students with the process skills and scientific attitudes essential for navigating the challenges of the 21st century.

In an educational context, the Natural Science (IPA) subject is expected to serve as a vehicle for students to learn about themselves and the natural world, while also developing critical thinking, problem-solving abilities, and scientific skills. Ideal Natural Science instruction emphasizes the process of discovering concepts through authentic scientific activities (Kemendikbudristek, 2022). However, the reality in the field reveals that Natural Science instruction still faces various challenges. Previous studies indicate that student learning outcomes tend to be low, active student engagement in the learning process remains insufficient, and critical thinking skills have not developed optimally (Haryanto et al., 2020). This situation highlights the need for innovative learning models that are more effective and student-centered.

One learning model considered capable of addressing these challenges is Problem-Based Learning (PBL). This model positions real-world problems as the starting point for learning, thereby encouraging students to seek solutions through processes of inquiry, discussion, and reflection (Ariani, 2020). Generally, the syntax of PBL comprises the following stages: problem orientation, organizing students for learning, guiding individual and group investigations, developing and presenting work products, and analyzing and evaluating the problem-solving process (Behnamnia et al., 2025). Furthermore, PBL requires students to work in groups, identify problems, formulate hypotheses, gather information from various sources, and devise solutions (Syamsidah & Suryani, 2018). Thus, PBL focuses not only on content mastery but also simultaneously develops critical thinking skills, collaborative abilities, and the application of theory in practical contexts (Subiyantoro & Asprila, 2024).

Various studies have been conducted to examine the effectiveness of the PBL model in enhancing the quality of science education. Meta-analyses and literature reviews indicate a positive impact of PBL on students' conceptual understanding, science process skills, and critical thinking. However, these research findings remain scattered across various journals, covering diverse contexts, educational levels, and curricula. Although many studies have examined the effectiveness of PBL, very few investigations have specifically analyzed trends in PBL implementation, particularly within the context of the Kurikulum Merdeka (Independent Curriculum) in Indonesia (Ariyani & Kristin, 2021). The Kurikulum Merdeka, which is being widely implemented, offers greater flexibility for teachers and emphasizes student-centered learning alongside the strengthening of the Profil Pelajar Pancasila. This naturally introduces unique nuances and challenges regarding the application of the PBL model aspects that have not yet been comprehensively mapped out.

METHODS

This study uses the literature review method. The data source is in the form of 15 research articles published in national journals indexed by SINTA 2 to SINTA 4 during the period 2020–2024. The article was selected based on several criteria, namely discussing the application of the

Problem Based Learning model; carried out in science learning; contains clear research results; published in SINTA-indexed journals. Data were analyzed descriptively by grouping articles based on the year of publication, level of education, learning materials, media used, research methods, and research results.

This study uses the Systematic Literature Review (SLR) method to identify, evaluate, and synthesize research results regarding the application of the *Problem Based Learning* (PBL) model in science learning. The stage of identifying article search is carried out through Google Scholar with the keywords used, Problem Based Learning Science, PBL learning science, PBL and science learning outcomes. The inclusion criteria for articles are chosen if they meet the following criteria: published in 2020–2024, indexed by SINTA, discuss the application of the PBL model, focus on science learning, and contain clear research results. Exclusion criteria if articles are not indexed by SINTA, review articles, articles other than the field of science and articles that do not use the PBL model. The data was analyzed in a qualitative descriptive manner by grouping the year of publication, level of education, science material, learning media, research methods, and research results.

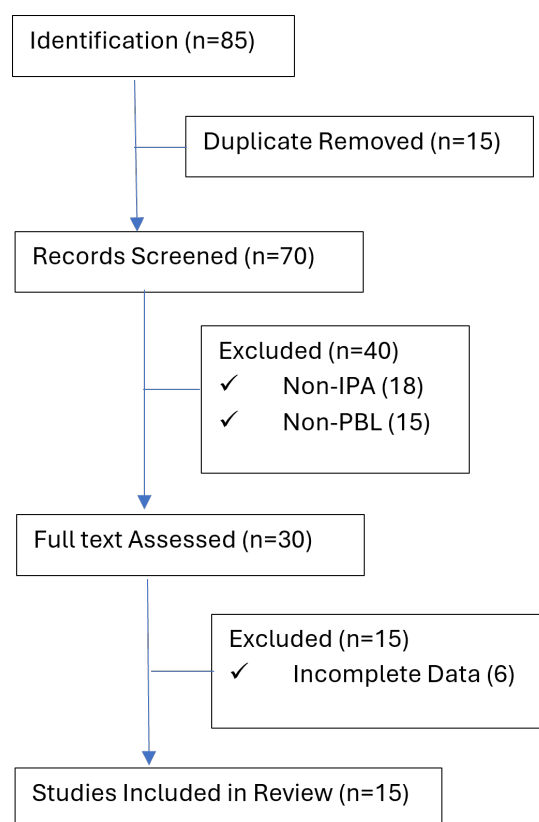


Figure 1. Prisma Flowchart

RESULTS AND DISCUSSION

Results

This section presents the findings derived from the systematic review of the 15 selected articles. The results are organized into several sub-sections based on the predetermined analytical framework: characteristics of the studies, educational levels and methodologies, distribution of science topics, the role of instructional media, and the reported impacts of PBL.

Characteristics of the Selected Studies

As illustrated in the PRISMA flowchart (Figure 1), the initial search yielded 85 records. After removing 15 duplicates, 70 records were screened. A total of 40 records were excluded because they did not focus on science education (n=18) or did not implement the PBL model (n=15). Of

the remaining 30 full-text articles assessed, 15 were excluded due to incomplete data, resulting in 15 studies included in the final review.

The 15 reviewed articles were published between 2020 and 2024 in national journals indexed by SINTA 2 to SINTA 4. Table 1 summarizes the characteristics of each study, including the author, publication year, journal index, science topic, instructional media, research method, and main findings.

Tabel 1. Result Articles

No	Author(s) & Year	SINTA Index	Science Topic	Instructional Media	Research Method	Main Findings
1	Yuniarsih, (2021)	SINTA 3	Water cycle	Diorama	CAR	Improved students' science learning outcomes on the water cycle topic.
2	Widura et al., (2021)	SINTA 2	Life cycles; Force and motion	Google Meet (Virtual)	CAR	Improved students' science learning outcomes.
3	Sujana et al., (2021)	SINTA 2	Changes in states of matter	Audio-visual media	CAR	Increased students' science learning outcomes.
4	Ramadhani, (2021)	SINTA 3	Water cycle	Zoom Meeting	CAR	Improved students' problem-solving skills.
5	Novi et al., (2021)	SINTA 2	Static force and electricity	Google Meet & WhatsApp	CAR	Improved students' science learning outcomes.
6	Laksmi & Suniasih, (2021)	SINTA 2	Water cycle	E-Comic	R&D (ADDIE)	The PBL-based E-Comic was feasible and suitable for science learning.
7	Kurniawan et al., (2020)	SINTA 2	General Science	Audio-visual media	Quasi-experiment	Significant effect of PBL with audio-visual media on conceptual understanding.
8	Devi & Bayu, (2020)	SINTA 2	General Science	Visual media	Quasi-experiment	Significant effect of PBL on critical thinking skills and learning outcomes.
9	Artawan et al., (2021)	SINTA 2	Heat and its transformation	Not specified	CAR	Improved science learning outcomes for grade V students.
10	Anggraini et al., (2025)	SINTA 2	Properties of matter	Interactive multimedia	R&D (4D Model)	The PBL-oriented interactive multimedia was suitable for the learning process.
11	Yasmini, (2021)	SINTA 4	General Science	Not specified	CAR	Increased students' motivation to learn science.
12	Rambe et al., (2024)	SINTA 4	General Science	Not specified	Quasi-experiment	Improved critical thinking skills and science learning outcomes.
13	Ramadhani, (2021),	SINTA 4	General Science	Not specified	CAR	Improved students' ability to understand science concepts.
14	(Ariyani & Kristin, 2021)	SINTA 4	Materials and their changes	Not specified	CAR	Improved students' understanding of the lesson.
15	Halimah et al., (2023)	SINTA 4	General Science	Not specified	CAR	Improved students' critical thinking skills.

Educational Levels and Research Methodologies

The analysis revealed a significant disparity in the educational levels targeted by the studies. The vast majority of the reviewed research (14 out of 15 studies) was conducted at the elementary school level, with only one study focusing on the junior high school level.

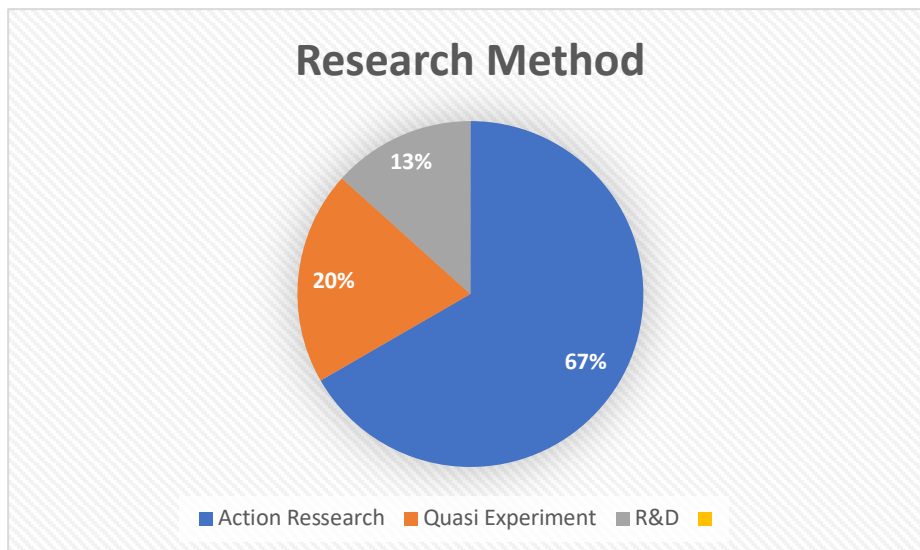


Figure 2. Research Method

Regarding the methodological approaches (see Figure 2), Classroom Action Research (CAR) or Penelitian Tindakan Kelas (PTK) was the most dominant method, employed in 10 studies (67%). This was followed by quasi-experimental designs in 3 studies (20%) and Research and Development (R&D) models in 2 studies (13%).

Distribution of Science Topics

The 15 reviewed articles covered a variety of science topics. As shown in Figure 3, the most frequently researched topics were the water cycle (36%) and changes in the form of objects (36%). This was followed by force and motion (18%), and temperature and heat (9%).

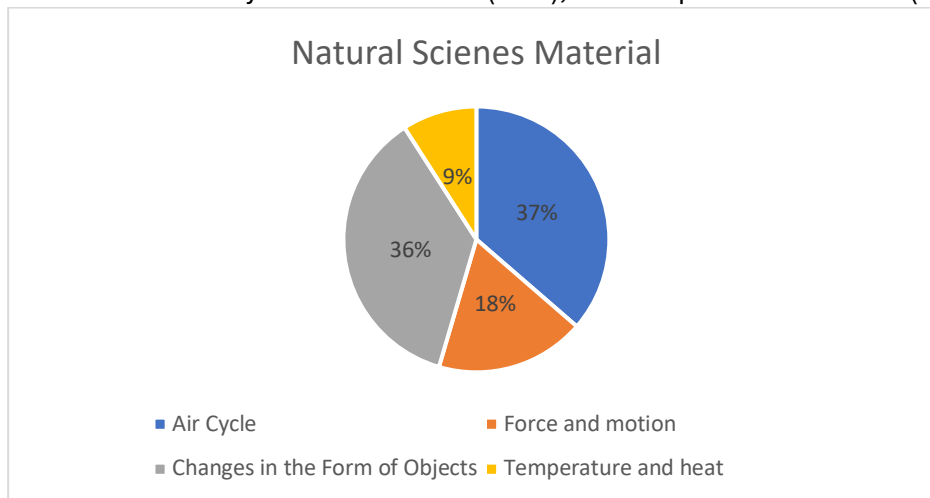


Figure 3. Distribution Material

The Role of Instructional Media in PBL Implementation

The synthesis of the literature indicated that the application of the PBL model was frequently integrated with specific instructional media. As summarized in Table 2, the media used varied, including visual media (dioramas), audio-visual materials, e-comics, interactive multimedia, and virtual platforms (Zoom, Google Meet, and WhatsApp).

Tabel 2. Role of Media PBL

Media Type	Studies
Diorama	Yuniarsih, (2021)
Audio-visual	Sujana et al., (2021) ; Kurniawan et al., (2020)
Visual	Devi & Bayu, (2020)
E-Comic	Laksmi & Suniasih, (2021)
Interactive Multimedia	Anggraini et al., (2025)
Virtual Platforms (Zoom, Google Meet, WhatsApp)	Novi et al., (2021) ; Ramadhani, (2021) ; Widura et al., (2021)

Reported Impacts of PBL on Student Outcomes

The analysis of the research findings revealed that the application of PBL consistently yielded positive outcomes across all 15 studies. The reported impacts can be categorized into three main areas:

Learning Outcomes and Conceptual Understanding

Studies by [Artawan et al., \(2021\)](#), [Novi et al., \(2021\)](#), [Sujana et al., \(2021\)](#), [Widura et al., \(2021\)](#), [Yuniarsih, \(2021\)](#) reported significant improvements in students' science learning outcomes and conceptual understanding following the implementation of PBL.

Critical Thinking and Problem-Solving Skills

Research by [Devi & Bayu, \(2020\)](#), [Halimah et al., \(2023\)](#), [Ramadhani, \(2021\)](#), [Rambe et al., \(2024\)](#) demonstrated that PBL implementation enhanced students' critical thinking and problem-solving abilities.

Learning Motivation

One study by [Yasmini, \(2021\)](#) specifically reported an increase in students' motivation to learn science.

Discussion

The primary finding of this review is that Problem-Based Learning (PBL) consistently exerts a positive impact on science education in Indonesia, particularly in improving learning outcomes, conceptual understanding, and critical thinking skills. Furthermore, the effectiveness of PBL is significantly amplified when integrated with specific instructional media. These findings align with the broader international evidence base, yet they also reveal distinct contextual patterns that warrant deeper examination.

The Dominance of CAR and Elementary Level Focus

The results indicate that 67% of the reviewed studies employed Classroom Action Research (CAR) and 93% were conducted at the elementary school level. This finding suggests that PBL is predominantly viewed by Indonesian educators as a practical intervention to solve immediate classroom problems rather than a theoretical model to be tested through rigorous experimental designs. This aligns with the current educational landscape in Indonesia, where teachers are often required to conduct CAR for professional development and promotion purposes. However, the heavy reliance on CAR limits the generalizability of the findings. While CAR is excellent for localized improvement, it lacks control groups to definitively prove causality compared to quasi-experimental designs.

This methodological pattern stands in contrast to international trends. A meta-analysis by [Liu & Pásztor, \(2022\)](#) synthesizing 50 empirical studies with 5,210 participants found that PBL had a significant overall effect on critical thinking ($SMD = 0.640$, $p < .001$), with quasi-experimental and randomized designs predominating. Similarly, [Usman et al. \(2025\)](#) reported an overall effect size of 0.93 (95% CI: 0.15–1.71) for PBL's impact on scientific literacy across 10 empirical studies, though with substantial heterogeneity ($I^2 = 94\%$). These international syntheses rely on controlled designs that allow causal inferences, a methodological rigor that is largely absent from the Indonesian CAR-dominated literature. This discrepancy highlights a critical gap: while Indonesian teachers are actively implementing PBL and documenting their classroom experiences, the field lacks the comparative evidence needed to establish PBL's

effectiveness relative to conventional instruction on a larger scale.

The concentration of research at the elementary level further distinguishes the Indonesian literature from global patterns. A recent systematic review by [Affandy et al., \(2026\)](#) concluded that PBL enhances critical thinking and collaboration, but its success is strongly influenced by adaptive instructional design, adaptation of learning materials to local contexts, and teacher training. The near-absence of Indonesian PBL research at the junior and senior high school levels is concerning, as secondary education involves more complex scientific concepts that inherently require higher-order thinking and problem-solving skills, areas where PBL is theorized to excel. A meta-analysis by [Wulandari et al., \(2025\)](#) focused specifically on junior high school science learning in Indonesia reported a very high effect size ($ES = 1.19$) for PBL on cognitive learning outcomes, suggesting that PBL is indeed potent at this level and deserves greater research attention.

The Mechanism of PBL in Improving Learning Outcomes

The consistent improvement in learning outcomes across the reviewed studies can be explained through the lens of constructivist theory. As noted by [Novi et al., \(2021\)](#) and [Widura et al., \(2021\)](#), PBL trains students to think at a higher level by presenting authentic, real-world problems. This finding aligns with the fundamental premise of constructivism, which posits that knowledge is constructed when students actively engage with their environment rather than passively receiving information. Recent meta-analytic evidence reinforces this mechanism: a review of PBL's impact on critical and reflective thinking concluded that PBL generally produces moderate to large positive effects on critical thinking, with key mechanisms including collaborative inquiry, self-directed learning, and iterative problem-solving ([Liu & Pásztor, 2022](#)).

However, the effectiveness of PBL is not unconditional. [Liu and Pásztor, \(2022\)](#) found that short-term PBL interventions were ineffective, whereas long-term interventions produced stronger effect sizes. This finding has direct implications for the Indonesian context: many of the CAR studies reviewed here span only two to three cycles over a brief period, potentially underestimating PBL's full potential. Furthermore, the high heterogeneity observed in Indonesian meta-analyses (e.g., $I^2 = 92.90\%$ in a recent synthesis) suggests that implementation quality, rather than the mere presence of PBL, is the decisive factor in determining outcomes. This underscores the need for sustained, well-scaffolded PBL implementation rather than brief, sporadic interventions.

The Critical Role of Instructional Media

A practical and theoretically significant finding of this review is the critical role of instructional media in mediating PBL effectiveness. The data show that PBL is most successful when supported by media such as dioramas, audio-visual materials, and e-comics. This is consistent with Mayer's Cognitive Theory of Multimedia Learning, which posits that students learn better when information is presented through both visual and verbal channels. In the context of elementary science, abstract concepts like the water cycle or changes in object forms are difficult to grasp without visualization. Therefore, the integration of media transforms abstract PBL scenarios into concrete learning experiences, reducing cognitive load and enhancing conceptual understanding. A meta-analysis on blended PBL confirmed that integrating media and technology into PBL significantly improves students' 21st-century skills in science learning, though with high heterogeneity ([Öndes, 2024](#)).

Research Gaps and Implications for Future Practice

While the findings are promising, this review also reveals critical gaps. The data show that 36% of studies focused on the water cycle, while temperature and heat accounted for only 9%. This topical imbalance suggests that researchers tend to recycle popular themes that are easy to visualize, leaving other equally complex topics underexplored.

More significantly, none of the reviewed studies explicitly integrated local wisdom (ethnoscience) into their PBL media. This is a notable gap given Indonesia's rich cultural diversity and the growing body of research demonstrating the effectiveness of ethnoscience-based approaches. For instance, a study by [Sutanto et al., \(2026\)](#) developing an ethnoscience-based teaching module on vibrations and waves integrated local wisdom from East OKU Regency and achieved a "Highly Valid" rating (Aiken's $V = 0.90$) from expert validators, demonstrating the feasibility of culturally contextualized science materials. Similarly, research by [Nirmala et al., \(2024\)](#) on integrating local wisdom into project-based learning for medicinal plant processing in Jambi showed that such approaches enhance students' understanding of biological concepts while connecting them with local cultural practices. Integrating such local wisdom into PBL scenarios could enhance both scientific literacy and cultural preservation simultaneously, addressing the "contextual relevance" challenge identified in international PBL literature ([Affandy et al., 2026](#)).

Limitations

This study has several limitations. First, the review was limited to 15 articles indexed by SINTA, which restricts the scope and potentially excludes relevant international literature. Second, the exclusion of incomplete-data articles might have inadvertently removed studies with null or negative findings, potentially introducing a degree of publication bias. This concern is echoed in the broader literature: a meta-analysis by Usman et al. (2025) on PBL and scientific literacy reported substantial heterogeneity ($I^2 = 94\%$), which may partly reflect variability in study quality and reporting standards. Third, the heavy reliance on CAR in the reviewed studies limits our ability to draw causal conclusions about PBL's absolute effectiveness.

Future research should employ larger and more diverse samples across secondary and higher education levels, utilize rigorous experimental designs (e.g., randomized controlled trials or well-controlled quasi-experiments), and develop PBL media that specifically integrate local wisdom to meet the demands of 21st-century scientific literacy. Additionally, future studies should examine the moderating role of intervention duration, as evidence suggests that short-term PBL may be insufficient to produce meaningful gains in critical thinking ([Liu & Pásztor, 2022](#)).

CONCLUSION

This study aimed to synthesize the research trends and effectiveness of Problem-Based Learning (PBL) in Indonesian science education by reviewing 15 SINTA-indexed articles published between 2020 and 2024. The findings demonstrate that PBL consistently yields positive impacts on students' science learning outcomes, conceptual understanding, and critical thinking skills. Furthermore, the effectiveness of PBL is significantly amplified when integrated with instructional media, such as dioramas, audio-visual materials, and e-comics.

Theoretically, this study contributes to the literature by confirming the robust applicability of constructivist and multimedia learning theories within the Indonesian elementary science context. Practically, these findings provide a clear roadmap for educators and curriculum developers: PBL should not be implemented in isolation but must be paired with appropriate visual or digital media to help students grasp abstract scientific concepts. Additionally, the dominance of Classroom Action Research (CAR) indicates that PBL is highly adaptable for localized, continuous classroom improvement. Future research should urgently expand the exploration of PBL to the junior and senior high school levels, as secondary education involves more complex scientific concepts that inherently require higher-order thinking skills. Furthermore, future studies should design PBL interventions that explicitly integrate local wisdom (ethnoscience) and focus on underrepresented science topics, such as heat and temperature. Addressing these gaps is essential to ensure that science education in Indonesia becomes not only academically rigorous but also culturally relevant and contextually meaningful.

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REFERENCES

- Affandy, H., Sunarno, W., Suryana, R., & Harjana. (2026). Unveiling the global instructional impact of problem-based learning in science education: A comprehensive systematic review. *Interdisciplinary Journal of Problem-Based Learning*, 20(1). <https://doi.org/10.14434/ijpbl.v20i1.37007>
- Anggraini, A., Hasan, G. N. U., Zuhriyah, I. A., & Aminullah, M. (2025). Integrasi Teknologi dalam Evaluasi Pembelajaran: Model Technological Pedagogical Content Knowledge (TPACK) untuk Mengembangkan Kompetensi Digital. *Pedagogik Journal of Islamic Elementary School*, 722–735. <https://doi.org/10.24256/pijies.v8i2.7514>
- Ariani, R. F. (2020). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis Siswa SD Pada Muatan IPA. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 4(3), 422–432. <https://doi.org/10.23887/jipp.v4i3.28165>
- Ariyani, B., & Kristin, F. (2021). Model Pembelajaran Problem Based Learning untuk Meningkatkan Hasil Belajar IPS Siswa SD. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 5(3), 353–361. <https://doi.org/10.23887/jipp.v5i3.36230>
- Artawan, I. K. A. S., Rati, N. W., & Pajarastuti, D. P. (2021). Penerapan Model Pembelajaran Problem Based Learning untuk Meningkatkan Hasil Belajar IPA Siswa Sekolah Dasar. *Jurnal Ilmiah Pendidikan Profesi Guru*, 4(2), 173–181. <https://doi.org/10.23887/jippg.v4i2.35582>
- Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, S. A. (2025). Relationship between creative thinking and outcomes in a digital STEM-based learning environment: A mixed methods case study. *Thinking Skills and Creativity*, 57, 101816. <https://doi.org/10.1016/j.tsc.2025.101816>
- Carin, & Sund. (1989). *Teaching Science Through Discovery*. Macmillan Publishing Company.
- Chiapetta, E. L., Koballa, T. R., & Collette, A. T. (1998). *Science Instruction in the Middle and Secondary Schools*. Prentice Hall.
- Devi, P. S., & Bayu, G. W. (2020). Berpikir kritis dan hasil belajar IPA melalui pembelajaran problem based learning berbantuan media visual. *Mimbar PGSD Undiksha*, 8(2), 238–252. <https://doi.org/10.23887/jjpgsd.v8i2.26525>
- Halimah, S., Usman, H., & Maryam, S. (2023). Peningkatkan kemampuan berpikir kritis dalam pembelajaran IPA melalui penerapan model pembelajaran problem based learning (PBL) di sekolah dasar. *Jurnal Syntax Imperatif: Jurnal Ilmu Sosial Dan Pendidikan*, 3(6), 403–413. <https://doi.org/10.36418/syntax-imperatif.v3i6.207>
- Haryanto, Asrial, & Ernawati, M. D. W. (2020). E-worksheet for science processing skills using kvisoft flipbook. *International Journal of Online and Biomedical Engineering*, 16(3), 46–58. <https://doi.org/10.3991/IJOE.V16I03.12381>
- Kemendikbudristek. (2022). Ilmu Pengetahuan Alam dan Sosial (IPAS) SD-SMA. *Merdeka Mengajar*.
- Kurniawan, I. K., Parmiti, D., & Kusmariyatni, N. (2020). Pembelajaran IPA dengan model problem based learning berbantuan media audio visual meningkatkan pemahaman konsep siswa. *Jurnal Edutech Undiksha*, 8(2), 80–92. <https://doi.org/10.23887/jeu.v8i2.28959>
- Laksmi, N. L. P. A., & Suniasih, N. W. (2021). Pengembangan Media Pembelajaran E-Comic

- Berbasis Problem Based Learning Materi Siklus Air pada Muatan IPA. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 5(1), 56–64. <https://doi.org/10.23887/jipp.v5i2>
- Liu, Y., & Pásztor, A. (2022). Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis. *Thinking Skills and Creativity*, 45. <https://doi.org/10.1016/j.tsc.2022.101069>
- Nirmala, N., Zurweni, Z., & Hamidah, A. (2024). The potential of the local wisdom PjBL model applied to the processing of medicinal plants in Talang Duku Village Jambi. *Integrated Science Education Journal*, 5(2), 110–114. <https://doi.org/10.37251/isej.v5i2.801>
- Novi, N. P., Suarjana, I. M., & Sudarmawan, G. A. (2021). Model Pembelajaran Problem Based Learning untuk Meningkatkan Hasil Belajar Muatan Pelajaran IPA Siswa Kelas IV SD. *Jurnal Penelitian Dan Pengembangan Pendidikan*, 5(2), 278–286. <https://doi.org/10.23887/jppp.v5i2.37427>
- Öndes, R. N. (2024). Impact of blended problem-based learning on students' 21st century skills on science learning: A meta-analysis. *International Journal of Education in Mathematics, Science and Technology*, 12(4), 1032–1052.
- Ramadhani, H. P. (2021). Peningkatan kemampuan pemecahan masalah pembelajaran IPA tentang siklus air melalui model pembelajaran problem based learning. *Kalam Cendekia: Jurnal Ilmiah Kependidikan*, 9(1). <https://doi.org/10.20961/jkc.v9i1.53803>
- Rambe, Y., Khaeruddin, K., & Ma'ruf, M. R. (2024). Pengaruh model problem based learning terhadap kemampuan berpikir kritis dan hasil belajar IPA pada siswa sekolah dasar. *Jurnal Riset Dan Inovasi Pembelajaran*, 4(1), 341–355. <https://doi.org/10.51574/jrip.v4i1.1372>
- Subiyantoro, S., & Asprila, F. D. (2024). Project-Based Learning: An Innovative Learning Model to Improve the Understanding of Science in Fifth-Grade Students. *Cognitive Development Journal*, 2(2), 40–48. <https://doi.org/10.32585/cognitive.v2i2.36>
- Sujana, D. M. A., Japa, I. G. N., & Yasa, L. P. Y. (2021). Meningkatnya hasil belajar IPA siswa melalui model problem based learning berbantuan media audio visual. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 5(2), 320–331. <https://doi.org/10.23887/jipp.v5i2>
- Sutanto, T., Akhsan, H., & Kistiono, K. (2026). Integrating local wisdom in science: Development and validation of ethnoscience teaching modules for improving science literacy of junior high school students. *Integrated Science Education Journal*, 7(1). <https://doi.org/10.37251/isej.v7i1.2344>
- Syamsidah, & Suryani, H. (2018). *Buku Model Problem Based Learning (PBL): Mata Kuliah Pengetahuan Bahan Makanan*. Deepublish.
- Widura, I. D. G. S., Bayu, G. W., & Aspini, N. N. A. (2021). Penerapan model pembelajaran problem based learning untuk meningkatkan hasil belajar IPA. *Jurnal Ilmiah Pendidikan Profesi Guru*, 4(2), 190–199. <https://doi.org/10.23887/jppg.v4i2>
- Wulandari, W., Zahra, F. A., Yurnetti, Y., & Muttaqiin, A. (2025). Meta analysis on the applied of problem based learning in junior high school students to the science learning outcomes. *Universe*, 6(1). <https://doi.org/10.24036/universe.v6i1.651>
- Yasmini, I. G. K. (2021). Penerapan model pembelajaran Problem Based Learning untuk meningkatkan motivasi belajar IPA. *Journal of Education Action Research*, 5(2), 159–164. <https://doi.org/10.23887/jppp.v5i2.37427>
- Yuniarsih, R. (2021). Peningkatan hasil belajar IPA materi siklus air menggunakan model problem based learning dengan media diorama. *Kalam Cendekia: Jurnal Ilmiah Kependidikan*, 9(1). <https://doi.org/10.20961/jkc.v9i1.53857>