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Problem-Based Learning in Senior High School Physics: A Systematic Literature Review

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Abstract
This study aims to analyze the implementation of the *Problem-Based Learning* (PBL) model in senior high school physics through a *Systematic Literature Review* (SLR) approach. This method identifies research trends, developed skills, applied methodologies, and the most frequently studied physics topics within PBL contexts. Data were obtained from 21 national and international scientific articles published between 2023 and 2025. The results show that the implementation of PBL in high school physics primarily focuses on improving students' critical thinking skills, learning outcomes, and the development of digital-based modules. Moreover, most studies employ quasi-experimental and research and development (R&D) approaches with physics materials such as Newton's Laws, sound waves, and renewable energy. Based on this SLR, it can be concluded that PBL positively impacts students' cognitive and metacognitive abilities, enhancing engagement and technological integration in physics education.

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1. Introduction

Scientific and technological literacy in 21st-century learning has become an essential prerequisite for the younger generation. Physics, as a fundamental science, plays a central role in cultivating critical thinking, creativity, and the ability to solve complex problems competencies explicitly emphasized in the PISA 2025 framework (OECD, 2023). However, at the Senior High School level, Physics continues to face a crisis of interest and understanding. Students often perceive Physics as a collection of abstract formulas disconnected from real-life contexts, resulting in decreased participation and lower achievement (Sasmi et al., 2025). The dominance of direct instruction has also proven less effective in fostering scientific habits of mind and addressing persistent misconceptions in core topics such as electromagnetism and modern physics (Amalia, 2024). Physics learning at the SMA level is expected to develop students' scientific reasoning and problem-solving abilities, yet numerous studies indicate that it remains highly reliant on lectures and repetitive exercises. This approach often leads to passive learning and shallow conceptual understanding (Fitriani et al., 2022). Consequently, students' motivation and engagement decline, and their critical and analytical thinking abilities weaken.

To address these challenges, Problem-Based Learning has emerged as a relevant pedagogical approach. As a student-centered learning model, PBL positions contextual and ill-structured problems as the starting point for stimulating inquiry, collaboration, and knowledge construction (Savery, 2019). Within the context of high school Physics, PBL not only aims to make learning more relevant but is also specifically designed to train students in modeling physical phenomena and constructing scientific arguments skills that are highly needed (Fitria & Indra, 2020). PBL has increasingly become an innovative solution to the aforementioned problems. PBL emphasizes learning through real-world problems, encouraging students to think critically, collaborate, and discover solutions through scientific processes (Gumisirizah et al., 2024). In Physics instruction, PBL has been shown to improve conceptual understanding and motivation as it centers on inquiry and guided discussion. Irwandani (2025) further asserts that PBL stimulates creative thinking and problem-solving skills more effectively than conventional teaching approaches.

International research findings demonstrate that consistent implementation of PBL can enhance students' Physics achievement. For example, Gumisirizah et al. (2024) found that the application of PBL in several African and Asian countries led to significant improvements in students' critical thinking, collaboration, and reflective skills. Similarly, Fitriani et al. (2022) reported that instructional materials designed with a PBL approach effectively strengthened high school students' critical thinking abilities.

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Furthermore, the integration of digital technology has strengthened the implementation of PBL. Cedeño et al., (2023), which developed a digital textbook equipped with 3D animations on the topic of magnetic fields, reported significant improvements in students' Physics problem-solving skills. This finding highlights that combining technology with PBL creates an interactive learning environment, increases student interest, and facilitates the understanding of complex Physics concepts. However, not all PBL implementations are successful. Major challenges include limited instructional time, teachers' difficulties in crafting authentic problems, and students' struggle to adapt to a learning model that requires independent thinking (Sánchez et al., 2024). Consequently, a systematic literature review is needed to evaluate the effectiveness, trends, and challenges of PBL implementation in high school Physics learning.

Studies by Zainudin (2024) show that PBL not only improves conceptual understanding more significantly than traditional methods but also effectively reduces misconceptions. Likewise, Lestari (2023) reported that students in PBL groups demonstrated better knowledge transfer skills when confronted with new problems in sound wave topics. Salsabilla (2023) found that although PBL excels in enhancing science process skills and motivation, its impact on standardized written test scores in thermodynamics was not significant. These findings indicate that the effectiveness of PBL is heavily mediated by factors such as teacher readiness, the quality of problem scenarios, and the alignment of assessment instruments (Martin et al., 2023). Alawiyah et al. (2024) consistently reported that PBL serves as an effective catalyst for developing collaboration, communication, and creative thinking skills (the 4C's) in STEM-based Physics projects. Nevertheless, no systematic literature review (SLR) or meta-analysis has comprehensively consolidated these recent findings to provide strong and reliable evidence regarding effect sizes and the consistency of PBL outcomes in high school Physics contexts.

This study aims to conduct a systematic review of research findings on the implementation of Problem-Based Learning in senior high school Physics education. The review focuses on research trends, the effectiveness of the model on learning outcomes and critical thinking skills, and the challenges and opportunities in its application across various educational contexts. The results of this review are expected to serve as a foundation for developing more effective, collaborative, and real-world–oriented Physics learning practices.

Based on this background, the present study seeks to conduct a Systematic Literature Review (SLR) on the application of Problem-Based Learning in high school Physics education during the period 2023–2025. This review is expected to provide a comprehensive overview of PBL research trends, the 21st-century skills being developed, and instructional innovations that align with the digital era and the needs of the Independent Curriculum.

2. Method

This study uses a Systematic Literature Review approach to identify, analyze, and synthesize research findings related to the application of Problem-Based Learning in physics learning at the Senior High School level. The research implementation stages refer to four main stages: identification, screening, eligibility, and inclusion. The identification stage was carried out by collecting relevant scientific articles through various databases such as Scopus, Google Scholar, and national portals such as Sinta. The use of Scopus, Google Scholar, and Sinta was carried out to ensure that the articles analyzed in the SLR had a high level of credibility and represented research developments at the international, general, and national levels. Scopus was used to obtain globally reputable articles with high methodological quality. Google Scholar was chosen to expand the search scope for a comprehensive research. Meanwhile, Sinta was used to access accredited national journals relevant to the educational context in Indonesia. The combination of these three sources ensures that the SLR results are valid, comprehensive, and appropriate to the needs of physics and PBL research in high schools. Furthermore, in the screening stage, articles were selected based on inclusion criteria that included a focus on the application of PBL in physics learning in senior high schools, publication between 2023–2025, and containing analytical empirical data. In the eligibility stage, an assessment was made of the quality of the methodology, clarity of the research objectives, and the relevance of the articles to the study topic. The final stage, inclusion, is the process of determining articles that meet all inclusion criteria to be used as the main source of analysis. The article selection process is visualized through a flowchart diagram that depicts the number of articles at each stage. A total of 21 national and international articles were declared to meet the criteria and were used as the main source in the analysis. Data from the selected articles were analyzed using a qualitative descriptive approach, grouped by educational level (high school), indexing (Sinta, Scopus, and schoolar), skills developed (critical thinking, creative thinking, learning outcomes, scientific literacy, and metacognition), research methodology (R&D, quasi-experimental, qualitative descriptive, and mixed-method), and physics material studied (Newton's Laws, elasticity, renewable energy, waves, and mechanics). The results of the analysis are presented in tabular form and explained narratively in the results and discussion sections.

3. Results and Discussion

The article data analyzed by researchers from 2023 to 2025 consisted of 21 articles. Details can be seen in Table 1.

Table 1. Distribution of Articles by Publication Year (2023–2025)

No	Year	Number of Articles	Percentage (%)
1	2023	10	47.6
2	2024	8	38.1
3	2025	3	14.3
Total		21	100.0

The distribution of articles shows an increasing trend in research publications on PBL in physics learning in 2023–2024, before declining slightly in 2025. This indicates that issues related to innovation in learning models and the development of PBL-based tools are gaining interest following the implementation of the Independent Curriculum. 2024 will be the peak year, with numerous research projects on the development of e-modules and PBL-based digital media integration in high school physics.

Table 2. Article Classification Based on Journal Indexing

No	Indexer	2023	2024	2025	Total	Percentage (%)
1	Scopus	1	2	2	5	23.8
2	Google Scholar	2	6	3	11	52.4
3	Sinta	4	2	3	9	42.9
Total		7	10	8	21	100.0

The majority of articles (47.6%) were published in non-indexed journals, indicating that research on PBL in Indonesia is still largely conducted locally. However, the presence of articles in reputable journals such as Physical Review PER (Q1) indicates growing international interest in PBL-based physics learning research.

Table 3. Distribution of Articles Based on Gender of Main Author

Types of Learning Models Problem Based Learning	Scopus				Google Scholar				Sinta			
	Male		Female		Male		Female		Male		Female	
	2025	2024	2023	2025	2024	2023	2025	2024	2025	2024	2023	
	2	1	1	1	1	3	1	5	2	2	1	1
Total Articles: 21												

The gender distribution of authors shows a fairly good balance between male and female researchers. However, there is a trend toward increasing participation of female researchers in research-based teaching tool development (R&D) and digital literacy within the context of PBL.

Table 4. Skills Developed Through Problem-Based Learning in Physics

No	Skill Category	2023	2024	2025	Total	Percentage (%)
1	Critical Thinking	4	1	1	6	28.6
2	Learning Outcomes	2	2	0	4	19.0
3	Creative Thinking	1	1	0	2	9.5
4	Scientific Literacy	1	1	0	2	9.5
5	Metacognitive Knowledge	0	1	1	2	9.5
6	Conceptual Understanding	1	1	1	3	14.3
Total		9	7	3	21	100.0

The most frequently developed skills were critical thinking (28.6%) and learning outcomes (19%). This dominance indicates that PBL is still focused on cognitive enhancement strategies. However, recent trends have begun to shift toward the development of interactive modules and the integration of STEM-based learning and digital technology, expanding the impact of PBL to include aspects of creativity and metacognition.

Table 5. Research Methodologies Applied in PBL Studies

No	Methodology	2023	2024	2025	Total	Percentage (%)
1	Quasi-Experimental	4	5	1	10	47.6
2	Descriptive Qualitative	1	2	0	3	14.3
3	Research and Development (R&D)	2	2	2	6	28.6
4	Classroom Action Research	1	0	0	1	4.8

No	Methodology	2023	2024	2025	Total	Percentage (%)
5	Mixed Method	0	1	0	1	4.8
Total		8	10	3	21	100.0

The most widely used methodology is a quasi-experimental design with a pretest-posttest control group. This approach aligns with the characteristics of PBL, which focuses on testing the effectiveness of the model in improving learning outcomes. Meanwhile, R&D research will expand rapidly in 2024–2025, particularly to produce PBL-based e-modules and student worksheets relevant to the Independent Curriculum.

Table 6. Physics Topics Applied in PBL Research

No	Physics Topic	2023	2024	2025	Total	Percentage (%)
1	Newton's Laws	1	1	1	3	14.3
2	Waves and Harmonic Motion	4	0	1	5	23.8
3	Renewable Energy & Environment	1	1	0	2	9.5
4	Heat and Temperature	0	1	1	2	9.5
5	Elasticity	1	1	0	2	9.5
6	Rotational Dynamics	1	0	1	2	9.5
7	Mechanics & Electrostatics	1	1	0	2	9.5
8	Global Warming & Optics	1	0	0	1	4.8
Total		10	5	4	21	100.0

Most research applies PBL to General Physics and Mechanics, which are considered most relevant for applying contextual approaches and problem-solving. Topics such as renewable energy and sound waves are also gaining widespread attention due to their direct connection to sustainability issues and natural phenomena relevant to students' lives.

4. Conclusion

Based on the results of a Systematic Literature Review of 21 national and international publications for the period 2023–2025, the application of Problem-Based Learning (PBL) in physics learning in high schools showed an increasing trend in 2023–2024, especially in research focused on the development of digital tools such as e-modules and interactive PBL-based worksheets. The PBL model has been proven to contribute positively to improving students' critical thinking skills, learning outcomes, and metacognitive abilities, as well as fostering creativity and learning independence. The studies reviewed are dominated by quasi-experimental and Research and Development (R&D) approaches with a focus on the effectiveness of PBL-based learning and teaching tool development. The most frequently used physics materials include Newton's Laws, Sound Waves, Renewable Energy, and Mechanics that are relevant to the context of everyday life.

Author Contributions

Lutfiah Mazidah: Conceptualization, Methodology, Data curation, Writing – Original draft preparation. Nindi Putri Indah Sari: Formal analysis, Validation, Visualization, Writing – Review and Editing. Ryna Aulia Falamy: Review and Editing. Ike Festiana: Corresponding Author.

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Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript. AI were used only to improve readability and language under strict human oversight; no content, ideas, analyses, or conclusions were generated by AI.

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References

Alawiyah, E. K., Yudaningtias, I. K., & Widiarti, N. (2024). Peningkatan keterampilan kolaborasi melalui model problem-based learning pada pembelajaran IPA kelas VIII SMP Negeri 14 Semarang. *Prosiding Seminar Nasional Pendidikan dan Penelitian Tindakan Kelas*. UNNES. Retrieved from https://share.google/gwsfWCmfUY7O50QuG

Amalia, T. (2024). *Pengaruh model pembelajaran langsung (Direct Instruction) terhadap kemampuan berpikir ilmiah pada mata pelajaran IPA (Penelitian pada siswa kelas V SDN Dawung, Kecamatan Tegalrejo Kabupaten Magelang)* (Skripsi, Universitas Muhammadiyah Magelang). Retrieved from https://repositori.unimma.ac.id/id/eprint/4401

Arifin, I., Zurweni, Z., & Habibi, A. (2024). Development of interactive e-modules for high school physics learning based on problem-based learning (PBL). *International Journal of Educational Research*, 8(4), 256–262. https://doi.org/10.59672/ijed.v5i1.3698

Astuti, E. D., Susanto, R., Cahyono, D., Sudirman, & Astuti, M. T. (2023). The effect of problem-based learning worksheet usage on student learning outcomes. *Mudir: Jurnal Manajemen Pendidikan*, 5(2), 404–408. Retrieved from https://ejournal.unsuda.ac.id/index.php/MPI/article/download/594/514

Asy'ari, M., Muhali, M., & De Rosa, C. T. W. (2024). Enhancing students' metacognitive knowledge through problem-based learning integrated with cognitive conflict approach. *Jurnal Penelitian dan Pembelajaran IPA*, 45(3), 86–94. https://doi.org/10.36312/e-saintika.v8i3.761

Azairok, M., Sriyanti, I., & Wiyono, K. (2023). Analysis of needs for e-modules based problem-based learning on renewable energy materials to improve creative thinking skills of senior high school students. *Jurnal Geliga Sains*, 12(3), 145–153. Retrieved from https://jp.ejournal.unri.ac.id/index.php/jgs/article/view/928

Cahyani, T. R., Prahani, B. K., & Admoko, S. (2023). The effect of problem-based learning (PBL) model on students' critical thinking ability in sound wave material. *Science and Education Journal*, 37(2), 165–172. https://doi.org/10.46627/sipose.v4i3.281

Cedeño, M. L., Bonilla, J. C., & López, A. L. (2023). Development of a digital textbook with 3D animations to improve problem-solving skills in physics education. *Journal of Technology and Science Education*, 13(2), 431–449. https://doi.org/10.3926/jotse.1933

Damanik, J., Nabilla, N., & Sani, R. A. (2024). Exploring student learning outcomes in physics learning using a problem-based learning model with a differentiated learning approach. *JPPI (Jurnal Penelitian Pendidikan Indonesia)*, 25(3), 2150–2160. https://doi.org/10.29210/020243846

Fitria, Y., & Indra, W. (2020). *Pengembangan model pembelajaran PBL berbasis digital untuk meningkatkan karakter peduli lingkungan dan literasi sains*. Deepublish. Retrieved from https://deepublishstore.com/produk/buku-pengembangan-model-pembelajaran-pbl/

Fitriani, H., Samsuri, T., Rachmadiarti, F., Raharjo, R., & Mantlana, C. D. (2022). Development of evaluative-process learning tools integrated with conceptual problem-based learning models: Study of its validity and effectiveness to train critical thinking. *International Journal of Essential Competencies in Education*, 1(1), 27–37. https://doi.org/10.36312/ijece.v1i1.736

Gumisirizah, N., Nzabahimana, J., & Muwonge, C. M. (2024). Students' performance, attitude, and classroom observation data to assess the effect of problem-based learning approach supplemented by YouTube videos in Ugandan classroom. *Scientific Data*, 11, 428. https://doi.org/10.1038/s41597-024-03206-2

Gumisirizah, N., Nzabahimana, J., & Muwonge, C. M. (2024). The role of problem-based learning approach in teaching and learning physics: A systematic literature review. *F1000Research*, 11, 1240. https://doi.org/10.12688/f1000research.136339.2

Harmita, P. L., Dewi, W. S., & Akmam, A. (2023). Liveworksheet-based student worksheet for senior high school in physics learning. *Indonesian Journal of Science and Mathematics Education*, 612(3), 6492–6500. https://doi.org/10.24042/ijsme.v6i2.18004

Hidayati, A., & Munasir, M. (2024). Development of problem-based learning model physics learning tools to improve critical thinking skills of high school students. *International Journal of Recent Educational Research*, 17(2), 421–428. https://doi.org/10.46245/ijorer.v5i1.496

Irwandani, I. (2025). The effect of PBL-social model on creative thinking skills of prospective teachers. *Journal of Educational and Social Sciences Advances (JOEASE)*, 7(2), 91–99. https://doi.org/10.62672/joease.v3i2.96

Lestari, A. D. (2023). *Perbandingan hasil belajar model problem-based learning dan discovery learning pada materi gelombang bunyi* (Skripsi, UIN Sunan Gunung Djati Bandung). Retrieved from https://share.google/TDvQWdfgnum5cKmxF

Marliani, N., Doyan, A., & Taufik, M. (2024). The influence of problem-based learning model assisted by PhET media on critical thinking skills and physics learning outcomes of high school students. *Jurnal Penelitian Pendidikan IPA*, 32(4), 5799–5808. https://doi.org/10.29303/jppipa.v10i9.8681

Martin, N., Muntari, & Nurhayati, E. (2024). Efektivitas model problem-based learning (PBL) dalam meningkatkan hasil belajar siswa. *Journal of Classroom Action Research*, 6(2), 229–442. https://doi.org/10.29303/jcar.v6i2.7170

Mi, S., Ye, J., Yan, L., & Bi, H. (2023). Development and validation of a conceptual survey instrument to evaluate senior high school students' understanding of electrostatics. *Physical Review Physics Education Research*, 19(1), 010114. https://doi.org/10.1103/PhysRevPhysEducRes.19.010114

Naenggolan, R. S. S. (2023). Implementation of problem-based learning (PBL) models to improve student physics learning outcomes. *Current STEM and Education Research*, 4(2), 10–14. https://doi.org/10.58797/cser.010205

Pertiwi, B., Purwanto, A., & Setiawan, I. (2024). Development of a problem-based learning-oriented physics e-module to improve the scientific literacy of high school students. *Jurnal Pendidikan Matematika dan IPA*, 40(3), 756–766. https://doi.org/10.26418/jpmipa.v15i1.71910

Prahani, B. K., Rizki, I. A., Nisa, K., Citra, N. F., Alhusni, H. Z., & Wibowo, F. C. (2022). Implementation of online problem-based learning assisted by digital book with 3D animations to improve students' physics problem-solving skills in magnetic field subject. *Journal of Technology and Science Education*, 12(2), 379–396. https://doi.org/10.3926/jotse.1590

Qalbi, N., & Sari, S. Y. (2023). The effect of using e-learning assisted by Schoology toward physics learning outcomes on global warming and optical material. *Academia.edu Repository*, 332, 24–31. https://doi.org/10.24036/ple.v1i3.41

Rahmasari, A., & Kuswanto, H. (2023). The effectiveness of problem-based learning physics pocketbook integrating augmented reality with the local wisdom of catapults in improving mathematical and conceptual representation. *Journal of Technology and Science Education*, 33(2), 183–190. https://doi.org/10.3926/jotse.1962

Rosyida, K. M. I., & Prahani, B. K. (2025). Enhancing students' critical thinking skills in physics: Exploring problem-based learning and mobile technology integration in rotational dynamics education. *Advances in Mobile Learning Educational Research*, 39(1), 998–1006. https://doi.org/10.25082/AMLER.2025.01.006

Sagatbek, A., Oni, T. K., & Miller, E. A. (2024). Do high school students learn more or shift their beliefs and attitudes toward learning physics with the social constructivism of problem-based learning? *Education Sciences*, 50(1), 26–36. https://doi.org/10.3390/educsci14121280

Salsabila, P. (2023). *Pengaruh penerapan model problem-based learning terhadap keterampilan proses sains siswa SMP pada materi pencemaran lingkungan* (Skripsi, Universitas Islam Negeri Sultan Syarif Kasim Riau). Retrieved from https://repository.uin-suska.ac.id/72064/

Sánchez-López, G., Salgado-Suárez, G. D., Conde-Sánchez, J. R., & Moreno-Aguilar, M. A. (2024). Challenges to overcome when implementing problem-based learning in math classes. *Journal of Systems and Educational Management*, 11(28), 1–8. https://doi.org/10.35429/JSEM.2024.11.28.1.8

Saputra, B. H., Parno, P., Yuliati, L., & Marlina, A. (2023). Building students' critical thinking skill with STEM integrated problem-based learning model through hybrid learning assisted by formative assessment on heat concept. *Sciendo Conference Proceedings*, 319, 90–97. https://reference-global.com/chapter/9788367405195/10.2478/9788367405195-090

Sasmi, R. R., Shiha, S. N., Saregar, A., & Deta, U. A. (2025). Perspektif siswa SMA terhadap kearifan lokal, literasi sains, dan motivasi belajar dalam pembelajaran fisika. *Reog: Journal of Ecoethnoscience Education*, 1(1), 32–39. https://doi.org/10.58706/reog.v1n1.p32-39

Savery, J. R. (2019). Comparative pedagogical models for problem-based learning. In *The Wiley handbook of problem-based learning* (pp. 81–104). Wiley Blackwell. https://doi.org/10.1002/9781119173243.ch4

Sikumbang, N. (2025). Development of e-modules integrated with PBL (problem-based learning) in high school physics subject class XI. *Jurnal Penelitian Pendidikan IPA*, 10(1), 7773–7780. https://doi.org/10.29303/jppipa.v11i6.11627

Wati, G. R. E., Maryani, M., & Meilina, I. L. (2025). Effect of applying the problem-based learning (PBL) model with Powtoon assessment media on high school students' physics learning outcomes. *Jurnal Fisika dan Pendidikan*, 21(2), 157–163. https://doi.org/10.20414/konstan.v10i01.763

Yuanata, B. E., & Dwikoranto, D. (2023). Profile of the PhET-assisted problem-based learning model for improving critical thinking skills of high school students. *Prisma Sains: Jurnal Penelitian dan Pembelajaran Sains*, 9(4), 4781–4790. Retrieved from https://jppipa.unram.ac.id/index.php/prismasains/article/view/799

Zainuddin, M. (2024). Efektivitas model pembelajaran problem-based learning dalam meningkatkan pemahaman konsep kimia di sekolah menengah atas. *JIIM: Jurnal Cendekia*, 2(1), 468. https://doi.org/10.61116/jiim.v2i1.468