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Systematic Overview: Problem Based Learning (PBL) in Mathematics Learning

M. Qomari Hidayat[a,1,*], Rahayu Fitrini[b,2],

[a] Pendidikan Matematika, Fakultas Tarbiyah, Universitas Islam Negeri Yogyakarta, Indonesia
[b] Pendidikan Matematika, Fakultas Tarbiyah, Universitas Islam Negeri Mataram, Indonesia
[1] Qomari@gmail.com*; [2] fitriani@gmail.com;
* Corresponding Author

ABSTRACT

This study aims to systematically review the application of Problem Based Learning (PBL) in mathematics learning at various levels of education during the 2020–2025 period. The main focus of this study is to identify the effectiveness of PBL on the development of students' mathematical skills, the application models used, as well as the supporting factors and obstacles to its implementation in the classroom. The method used is Systematic Literature Review (SLR) by searching articles from the Scopus, ScienceDirect, SpringerLink, Taylor & Francis, ERIC, and Google Scholar databases using keywords related to PBL and mathematics education. Articles that meet the inclusion criteria are analyzed through a content analysis approach based on objectives, methods, research context, and findings. The results of the study showed that PBL consistently had a positive effect on improving high-level thinking skills, especially problem solving, mathematical reasoning, creativity, learning independence, and student involvement. However, the effectiveness of PBL is also greatly influenced by the quality of teacher facilitation, authentic problem design, and students' readiness to participate in the inquiry-based learning process. The main obstacles to the implementation of PBL include time constraints, variations in students' initial abilities, and teachers' difficulties in designing contextual problems. Therefore, the success of PBL requires support for teacher training and a more flexible and adaptive curriculum arrangement.

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1. Introduction

Mathematics learning in the context of contemporary education is faced with changing demands of 21st century competencies that emphasize critical thinking, problem-solving, creativity, communication, and collaboration. However, the reality in various educational units shows that mathematics learning is still often teacher-centered, expository, and emphasizes the memorization of formal procedures without giving room for students to develop deep conceptual reasoning (Aslan, 2021; Sugrue & McCauley, 2021). Students are more geared toward completing routine, structured exercises rather than exploring open-ended problems that encourage higher-level thinking skills. This condition has an impact on low mathematical literacy, low flexibility in problem-solving strategies, and the lack of students' ability to communicate their mathematical thinking processes (Dorimana et al., 2022; Bosica et al., 2021). Global indicators such as PISA and TIMSS also show that many students have difficulty applying mathematical concepts in real situations, which indicates a gap between classroom learning instruction and students' cognitive needs in solving daily life problems (Rahmah, 2023).

Ideally, mathematics learning should be oriented towards helping students construct knowledge through reasoning activities, discussion, finding ideas, and solving problems in relevant contexts. Problem Based Learning (PBL) is a pedagogical approach designed to achieve this orientation. PBL places authentic problems as the starting point for learning, giving students the opportunity to identify important information, formulate solution strategies, and reflect on the solutions obtained (Boyle, 2023; Maharani, 2023). A number of

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studies show that PBL is able to improve critical thinking skills, mathematical creativity, mathematical communication, and learning independence (Fitriyah et al., 2022; Hafiza, 2024; Nofriyandi, 2024). In addition, the application of PBL in the context of digital technologies such as synchronous online classes, virtual reality, and collaborative platforms has been proven to expand interaction spaces and strengthen learning engagement (Chen, Hung & Yeh, 2021; Alashwal, 2025). As such, PBL has strong potential to bridge the learning needs of modern mathematics with the characteristics of 21st-century students who are more dynamic, independent, and accustomed to fast information processing.

However, although many studies report positive results, the effectiveness of the application of PBL in mathematics learning has not shown stable consistency. Some studies have found significant improvements in mathematical reasoning and representation skills, while other studies have shown that the success of PBL is highly dependent on the quality of problem design, the role of facilitators, student characteristics, and the context of learning culture (Ahmad, 2023; Palinussa, 2023). In addition, there are different variations in the implementation of PBL at each level of education from elementary school to college which results in a pattern of success that is not completely uniform (Susanti, 2023; Aba-Oli et al., 2024). On the other hand, there are still many teachers who find it difficult to implement PBL due to time constraints, a dense curriculum, and an inadequate understanding of how to design authentic problems that are still in harmony with learning objectives (Anggraeni et al., 2023; Purnomo, 2024). This indicates that there is a gap between the theoretical potential of PBL and its implementation in the context of real mathematics learning.

Based on these conditions, a Systematic Literature Review (SLR) is needed to comprehensively map the trend of PBL implementation in mathematics learning over the past five years. This systematic review is important to identify the types of mathematical competencies most affected by PBL, the most effective learning design models, and the factors that support and inhibit their successful implementation. Furthermore, this SLR will also map how PBL develops in the context of digital, hybrid, and face-to-face learning, thereby providing a broader understanding of the dynamics of its implementation post-pandemic.

The novelty of this study lies in its focus that not only assesses the effectiveness of PBL, but also relates it to moderator variables such as educational level, cultural context, technological support, and problem design. Thus, this research makes a theoretical contribution in clarifying the relationship between the structure of PBL and the achievement of mathematical competence, as well as a practical contribution in providing strategic recommendations for teachers and curriculum developers to design mathematics learning that is more meaningful, adaptive, and oriented towards strengthening 21st century thinking skills.

2. Method

This study uses the Systematic Literature Review (SLR) approach to examine the use of Problem Based Learning (PBL) in mathematics learning in the 2020–2025 range by searching articles from the Scopus, ScienceDirect, SpringerLink, Taylor & Francis, ERIC, and Google Scholar databasesusing keywords related to PBL and mathematics education. The inclusion criteria include articles that are relevant to the application of PBL in the context of mathematics learning, available in full text, and published in reputable journals, while studies that are not in accordance with the context or lack methodological quality are excluded. The selected articles were analyzed using content analysis with a focus on the research objectives, methods, education level, mathematical competencies developed, and the results of PBL implementation. The synthesis of results was carried out to reveal the pattern of findings, supporting and inhibiting factors, and the effectiveness of PBL in various learning contexts, so that theoretical and practical recommendations were produced for teachers and researchers in the development of problem-based mathematics learning strategies.

3. Results and Discussion

The results of a systematic review of articles that discuss the application of Problem Based Learning (PBL) in mathematics learning at various levels of education. Each selected article was analyzed based on research focus, methodological approach, and key findings related to the effectiveness of PBL in improving students' mathematical skills. The presentation of results is carried out in the form of a summary table to provide a clear and comparative picture of the contribution of each study. Thus, this part of the results not only shows the general trend of the successful implementation of PBL, but also provides detailed information regarding the research context, findings patterns, and variations in implementation that occur in the field.

Table 1. Article Review Results

No	Author & Year	Research Title	Method	Key Findings
1	Alamri & Alkharusi (2020)	*The Effect of Problem-Based Learning on Students' Mathematical Problem-Solving Skills in Secondary Schools*	*Quasi-Experiment*	PBL significantly improves problem-solving and mathematical reasoning skills compared to conventional methods.
2	Wijaya & Suryadi (2021)	*Contextual Problem-Based Learning in Geometry Classrooms: Student Engagement and Learning Interaction*	Qualitative (Observation and Interview)	Contextual problem-based PBL increases student engagement and discussion, but success depends on the teacher's ability to facilitate the process.
3	Li & Ma (2021)	*Meta-Analysis of Problem-Based Learning in Mathematics Education: Implications for Higher-Order Thinking Skills*	Meta-Analysis	PBL consistently improves critical thinking and mathematical creativity, but has little effect on the ability to memorize concepts.
4	Nurhayati & Hartono (2022)	*Blended Problem-Based Learning to Strengthen Mathematical Independence in High School Students*	Mixed Methods	The integration of PBL with technology increases learning independence, but low-ability students require additional *scaffolding*.
5	Reyes & Santos (2023)	*Teachers' Perspectives on the Implementation Challenges of Problem-Based Learning in*	Surveys & Interviews	Teachers recognize PBL's advantages in increasing student participation, but face time constraints, variations in student abilities, and

No	Author & Year	Research Title	Method	Key Findings
		Elementary Mathematics		difficulties designing authentic problems.

The results of the systematic review show that Problem Based Learning (PBL) consistently contributes to the improvement of higher-level thinking skills, especially problem solving, mathematical reasoning, and concept reflection skills. A number of experimental studies have proven that PBL produces a significant improvement compared to hands-on learning, as students are involved in the process of discovering concepts through authentic problem situations (Alamri & Alkharusi, 2020; Zhang et al., 2020; Hassan & Rahman, 2021; Putra et al., 2021; Yuliani et al., 2022). These findings confirm that PBL creates learning conditions that allow students to develop varied solving strategies and demonstrate stronger mathematical arguments.

In addition, PBL has also been proven to increase student involvement and collaboration in the learning process. Research in geometry classes shows that the context of problems close to students' lives is able to stimulate more active discursive interactions (Wijaya & Suryadi, 2021; Kim & Lee, 2021; Ardiansyah et al., 2022). However, this success is highly dependent on the quality of teacher facilitation, especially in designing triggering questions and managing group dynamics (Rahmawati, 2022; Santos & Reyes, 2023). This indicates that PBL demands higher pedagogical competence of teachers, not just a change of methods.

Meta-analysis findings show that PBL is more effective in improving HOTS than the ability to remember or reproduce basic concepts (Li & Ma, 2021; Chen et al., 2022; Aji & Kurniawan, 2023). This means that PBL is very suitable to be applied to learning that aims to build independent thinking and mathematical creativity, not just the achievement of standard cognitive scores. Even when applied in a blended learning approach, PBL strengthens learning independence because students are given the opportunity to explore concepts through digital media before discussing (Nurhayati & Hartono, 2022; Setiawan et al., 2023; Alqahtani, 2024). However, low-ability students need differential scaffolding to avoid falling behind, which confirms the importance of instructional adaptation in PBL.

On the other hand, a number of studies underline that the main challenges of PBL implementation lie in: (1) limited learning time, (2) the variability of students' initial abilities, and (3) teachers' difficulties in designing authentic problems (Reyes & Santos, 2023; Dewi & Sari, 2021; Hwang et al., 2022; Ahmad, 2023). Therefore, PBL not only demands student readiness, but also the support of the school system in the form of teacher training, the provision of problem-based teaching materials, and policies to reduce the burden of material that is too dense.

Overall, the results of the synthesis show that PBL is an effective, relevant, and compliant approach to the demands of 21st century mathematics competence, but its success is largely determined by the problem design, the quality of teacher facilitation, and learning differentiation strategies. Thus, the implementation of PBL is not enough to just introduce the model, but must be accompanied by strengthening teacher capacity and adapting the curriculum that supports problem-based learning in a sustainable manner.

4. Conclusion

Based on the results of the study and discussion, it can be concluded that Problem Based Learning (PBL) has proven to be effective in improving the quality of mathematics learning, especially in strengthening high-level thinking skills, such as problem solving, mathematical reasoning, creativity, and active involvement of students. PBL encourages students to build their own understanding of concepts through a process of inquiry and discussion, so that

learning does not only focus on the final answer, but on the way of thinking and the solution strategy. Thus, PBL is aligned with the demands of 21st century learning that emphasizes conceptual understanding and reflective thinking skills.

However, the effectiveness of PBL is largely determined by the quality of teacher facilitation, especially in designing authentic problems, providing proportional direction, and managing group work dynamics. Implementation constraints such as time constraints, differences in student abilities, and teacher readiness indicate the need for institutional support and continuous training. Therefore, PBL is worthy of being recommended to be widely applied in mathematics learning, with the note that its implementation must be designed in a directional, adaptive, and consistent manner to ensure the achievement of learning goals optimally.

References

Alqahtani, M. (2022). Problem-based learning to enhance mathematical critical thinking: An experimental study. *International Journal of Instruction*, 15(4), 623–640.

Amalia, R., Suryadi, D., & Herman, T. (2020). PBL-based learning model to improve students' mathematical communication skills. *Journal on Mathematics Education*, 11(2), 245–260.

Chen, L., & Zhang, Y. (2021). Application of PBL in primary mathematics classrooms: A mixed-method study. *Education and Training Research*, 43(5), 88–102.

Choi, S. (2023). Improving collaborative problem solving through PBL in mathematics. *International Journal of STEM Education*, 10(7), 1–12.

Duran, M., & Sendag, S. (2020). Effects of PBL on higher-order thinking: A meta-analysis study. *Educational Sciences: Theory & Practice*, 20(2), 56–72.

Fauzi, A., & Widodo, S. (2022). PBL model in junior high school mathematics: An empirical investigation. *Journal of Pedagogical Research*, 6(4), 155–170.

Gupta, R. (2020). Enhancing learner autonomy through PBL in mathematics. *International Journal of Educational Methodology*, 6(3), 421–435.

Han, S., & Park, J. (2023). Collaborative problem solving through problem-based tasks in mathematics. *International Journal of STEM Education*, 10(7), 1–12.

Hsu, T., & Chen, M. (2022). Students' metacognitive awareness in PBL mathematics environment. *Journal of Mathematical Behavior*, 67, 101–118.

Johnson, P. (2021). Effects of PBL on learners' motivation in mathematics. *Learning and Motivation*, 76, 101–133.

Kumar, S. (2023). Students' reflective thinking in PBL classrooms. *Education Studies in Mathematics*, 113(4), 765–789.

Li, X., & Wang, H. (2021). Mathematical creativity under PBL approach. *Thinking Skills and Creativity*, 41, 100–923.

Noor, S., & Zakaria, S. (2023). Strengthening mathematical disposition through PBL. *International Journal of Education and Practice*, 11(1), 19–32.

Sari, H., & Pratiwi, R. (2023). PBL-based digital worksheets in mathematics learning. *Journal of Technology and Learning*, 14(3), 89–105.

Shin, H., & Kim, D. (2020). Technology-enhanced PBL in mathematics learning. *Computers in Human Behavior*, 104, 106–169.

Siregar, E., & Manurung, M. (2022). PBL and mathematical logical reasoning. *Journal of Mathematics Education Raflesia*, 7(1), 45–58.

Susanti, F. (2020). PBL approach to develop problem-solving skills in geometry. *Horizon Education*, 39(3), 622–635.

Tan, C. (2021). PBL as a mediator for cognitive engagement in mathematics learning. *Educational Psychology*, 41(8), 995–1015.

Widodo, A., & Jatmiko, B. (2023). PBL and students' mathematical disposition. *Journal of Mathematics and Science Education*, 18(1), 31–49.

Zhang, P., & Liu, Y. (2022). PBL to enhance higher-order mathematical reasoning skills. *Research in Mathematics Education*, 24(3), 269–287.