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Meta-Synthesis: Improving Mathematical Problem-Solving Skills Through Problem-Based Learning Models

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a b s t r a c t

Mathematical problem-solving skills are an essential component of mathematics education and support the achievement of Sustainable Development Goal (SDG) 4 on Quality Education. Indonesian students still demonstrate relatively low performance in mathematics. According to the 2022 Programme for International Student Assessment (PISA), Indonesia achieved an average mathematics score of 379, ranking 68th out of 76 countries. This result highlights a substantial gap between expected global mathematical competencies and actual student performance. Innovative learning approaches are required to improve students' abilities not only in obtaining correct answers but also in understanding, analyzing, and solving problems independently. One promising approach is Problem-Based Learning, which emphasizes contextual problems and student-centered learning. This study employed a Systematic Literature Review using the PRISMA framework to ensure a transparent and systematic literature selection process. A total of 210 articles were identified from Google Scholar, ScienceDirect, and DOAJ databases. After applying inclusion and exclusion criteria, 10 articles published between 2020 and 2025 were selected and analyzed using thematic synthesis techniques. The analysis focused on improving mathematical problem-solving skills and evaluating the effectiveness of the PBL model. The findings revealed that the implementation of PBL had a positive and significant impact on students' mathematical problem-solving skills across elementary, junior high, and senior high school levels. In addition, PBL enhanced students' conceptual understanding and collaboration skills, making it an effective strategy for mathematics learning.

Keywords:
Problem-Based Learning; Mathematical Problem-Solving Skills

INTRODUCTION

Mathematical problem-solving skills are at the heart of mathematics learning and are a crucial skill in supporting the achievement of Sustainable Development Goal (SDG) 4, namely Quality Education (Sevgi, 2021; UNESCO, 2020). Through this skill, students are expected to be able to use their mathematical knowledge to solve problems that arise in everyday life systematically and logically (Polya, 1945; Tice & Tice, 2010). However, Indonesian students' mathematical problem-solving skills remain relatively low. Based on the 2022 Programme for International Student Assessment (PISA) results, the average mathematics score of Indonesian students was only 379, ranking 68th out of 76 countries (Lewalter et al., 2023; OECD, 2023). This achievement indicates a significant gap between global expectations for mathematical competence and actual conditions on the ground. This indicates the need for learning innovation that is not only oriented towards the final result, but also towards the process of students in understanding, analyzing, and solving problems independently.

According to Polya (1945), mathematical problem-solving skills consist of four stages: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back. These four stages reflect a systematic thinking process in finding solutions to mathematical problems (Lester, 2013). However, various studies show that most students in Indonesia still experience difficulties in implementing these stages. Students often fail to understand the context of the problem, have difficulty determining appropriate strategies, and rarely re-examine the results obtained (Wilujeng & Novitasari, 2018). This condition is caused by learning that is still conventional and teacher-centered, where students are only accustomed to solving routine problems without being given the opportunity to face problems that require deeper reasoning and exploration.Dalam konteks pembangunan berkelanjutan, kemampuan pemecahan masalah matematis berperan penting dalam membentuk generasi yang mampu menalar dan mengambil keputusan berdasarkan data serta logika matematis (UNESCO, 2020). SDGs menekankan pentingnya pendidikan yang mendorong peserta didik untuk mampu mengatasi persoalan kehidupan nyata secara mandiri, sehingga matematika seharusnya tidak diajarkan sebagai kumpulan rumus, tetapi sebagai alat untuk menyelesaikan masalah nyata (Eremutha & Gabriel, 2018). Oleh sebab itu, pembelajaran matematika perlu diarahkan pada pendekatan yang memungkinkan siswa berpartisipasi aktif dalam menemukan solusi melalui permasalahan kontekstual. Salah satu model pembelajaran yang sejalan dengan prinsip tersebut adalah *Problem Based Learning* (PBL), yang menempatkan masalah sebagai titik awal proses belajar dan menuntun siswa menemukan solusi melalui penyelidikan sistematis (Barrows, 1981; Hmelo-Silver, 2004).

The Problem-Based Learning (PBL) model was developed based on constructivism theory, which positions students as active subjects in constructing their knowledge through problem-solving experiences (Sri Rejeki et al., 2024; Riyanto, et al., 2023). In mathematics learning, PBL helps students understand the meaning of a concept by linking it to real-life situations, so that students not only memorize formulas but also understand their application in everyday life contexts (Savery, 2015; Suwarma, 2024). Research conducted by Agustinsa et al. (2023) shows that the application of PBL can significantly improve students' mathematical problem-solving abilities because students are trained to understand problems, develop solution strategies, and review their results according to Polya's stages. The same finding was found by Karlina & Sari (2024) and N. U. Rahmawati et al. (2023), that the use of PBL makes students better able to identify problem elements and solve them independently and logically. Thus, PBL provides space for students to develop mathematical problem-solving abilities in a directed manner.

According to Arends (2012), the syntax or steps in the Problem Based Learning model consist of five stages: (1) orienting students to the problem, (2) organizing students for learning, (3) guiding individual and group investigations, (4) developing and presenting work, and (5) analyzing and evaluating the problem-solving process. Through this syntax, students are guided to understand the problem correctly, seek relevant information, develop strategies, test solutions, and review the results of their solutions (Torp & Sage, 2002; Ningrum et al., 2024). This process helps students internalize the problem-solving stages as proposed by Polya. Thus, the main focus in improving the quality of mathematics learning should be directed at strengthening mathematical problem-solving skills. The application of the Problem Based Learning model is believed to be able to overcome the gap in PISA results and address global challenges in mathematics education. Through learning that is centered on real-life problems, students can build a strong conceptual understanding and be skilled at applying mathematics in life contexts. This research is expected to strengthen empirical evidence regarding the effectiveness of PBL in improving mathematical problem-solving abilities, as well as provide a conceptual basis for the development of mathematics learning that is relevant to the 2030 SDGs vision.

METHODS

This research used a literature study. The literature study was conducted by collecting various references and previous research, which were then compiled to draw conclusions. The compiled results of previous research were then used to conclude: (1) How can the Problem-Based Learning Model improve students' mathematical problem-solving abilities? (2) Is the Problem-Based Learning Model effective in improving students' mathematical problem-solving abilities?

According to Dunford (2003), the following are the steps in literature review research: 1) Determine the theme. 2) The author searches for the information needed for the research. 3) Determine the research objectives. 4) Collect data sources relevant to the research topic and objectives. 5) Present the data. 6) Prepare a report, including compiling all collected data and presenting it appropriately, including citing all relevant sources.

This study applies a systematic literature review method following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, ensuring accountability and transparency in the literature selection process, reproducibility, and high-quality analysis. The PRISMA approach was chosen because of its ability to provide a systematic and comprehensive framework for identifying, selecting, and analyzing literature relevant to the research topic (Wibowo & Putri, 2021).

The inclusion criteria include journal articles published between 2020 and 2025 to ensure the novelty and relevance of research findings to current conditions. Articles must come from journals indexed by Google Scholar and Sinta-accredited journals to ensure the quality and academic credibility of publications with the following criteria: 1) The article focuses on students' mathematical problem-solving abilities. 2) Uses the Problem-Based Learning (PBL) learning model. 3) Published in journals indexed by Sinta 1–3 or Scopus (Q1–Q4). 4) Presents research results that can be analyzed descriptively qualitatively.

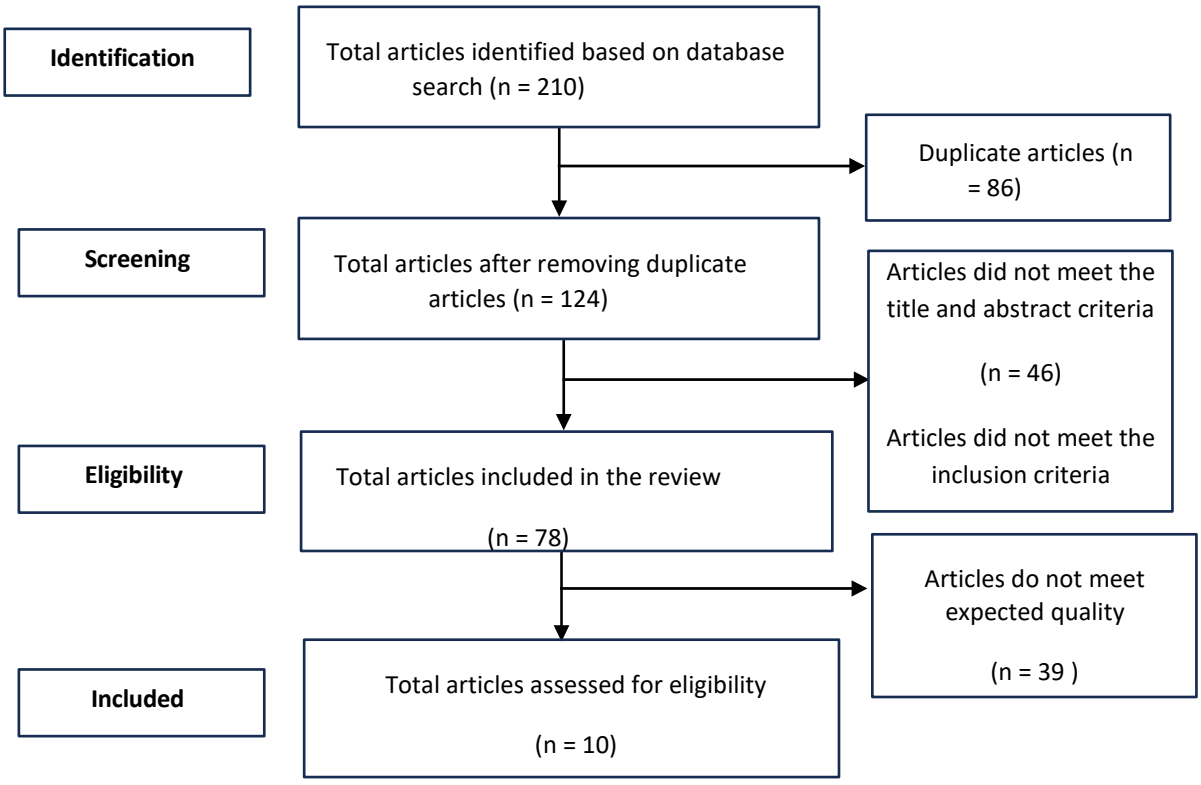
Conversely, exclusion criteria were applied to eliminate articles discussing mathematical problem-solving skills outside the context of formal education, articles in the form of literature reviews, research reports without empirical data, books, and studies that did not describe the methodology clearly and completely. Articles that only presented theoretical studies without empirical implementation were also excluded to ensure that the analysis focused on empirical evidence that could be verified and evaluated for quality.

Data collection was carried out through systematic stages according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, namely: Identification: Articles were searched for in databases such as Google Scholar, ScienceDirect, DOAJ, and Garuda. The keywords used were "Problem-Based Learning," "mathematical problem-solving skills," "mathematical problem solving," and "meta-analysis."

Screening: Articles found were selected based on data completeness, topic suitability, and the relationship between research variables. Eligibility: Articles meeting the inclusion criteria were re-evaluated to ensure contextual suitability (educational level, student characteristics, and PBL implementation).

Included: The final stage of the PRISMA process, in which the remaining articles were analyzed for eligibility for inclusion in the final research review, was used. 65 articles were identified and analyzed for eligibility, leaving only ten articles to be included in the study because they met all inclusion criteria. The following PRISMA flowchart illustrates the systematic flow of the selection process in a systematic literature review, from identification to the final selection of articles eligible for inclusion in the research analysis.

The analysis was conducted using a thematic synthesis approach as developed by Thomas and Harden (2008), with three main stages: Thematic coding of the research results, main findings, and conclusions of each article. Grouping codes into major themes such as: The influence of PBL on mathematical problem-solving ability, The role of learning independence in the implementation of PBL, Supporting and inhibiting factors for the effectiveness of PBL. Interaction patterns between learning independence and problem-solving ability. Narrative synthesis to find conceptual relationships and build an integrative theoretical model that describes the relationship between the three main variables.



Flowchart PRISMA

RESULT AND DISCUSSION

Results

In this study, articles spanning the period 2020 to 2025 were searched using Google Scholar. The article search used the keyword "mathematical problem-solving ability," specifically the keyword "Problem-Based Learning model." The article search yielded selected studies, providing the researchers with eight articles relevant to the research topic. The results showed that the Problem-Based Learning (PBL) model consistently had a positive and significant impact on improving students' mathematical problem-solving abilities at various levels of education (elementary, middle, and high school).

Some of the key findings include:

Improved learning outcomes and mathematical problem-solving skills:

Most studies show an increase in average problem-solving skill scores after implementing PBL. For example, research by Agustinsa et al. (2023) showed an increase in scores from 33.78 to 69.00, with a calculated t-value of 14.3 > t-table 2.07, indicating a significant effect.

Positive effects of PBL on learning motivation and engagement:

Sefa & Darko (2023) reported that implementing PBL improved mathematical problem-solving performance by 32% compared to conventional classes, while also increasing student motivation and engagement.

Effectiveness of digital-based PBL:

Several studies, such as those by Haqiqi & Syarifa (2021) and Nurhayati et al. (2023), show that the integration of digital media such as Liveworksheets and Scratch enhances the effectiveness of PBL. This makes students more active, creative, and able to understand mathematical concepts contextually.

Consistency across educational levels:

The meta-synthesis results show that the effectiveness of PBL is not limited to a specific level. This model has been successfully implemented from elementary to high school, with relatively consistent positive results.

Table 1
Literature Sources

No	Journal Title	Autors & Year	Subject	Method	Key Findings	Relevance to Reasearch
1	Meta Analysis: The effect of problem based learning models on mathematical problem solving skills	Edu-Mat Journal (2022)	Elementary-high school students	*Systematic Literature Review*	PBL has a positive effect with a medium-high *effect size.* PBL improves students' mathematical and collaborative problem-solving skills.	Provides a theoretical basis for the effectiveness of PBL broadly in the context of mathematics education.
2	Literature	Saravina	Elementar	Literature	PBL has	Strengthen

No	Journal Title	Autors & Year	Subject	Method	Key Findings	Relevance to Reasearch
	Review: The Effectiveness of Problem-Based Learning (PBL) Models to Improve Mathematical Problem-Solving Skills in Mathematics Learning	P.R., Firda M.P., Zefi H.F., & Bambang E.S. (2024)	y–High School Students (10 journals 2017–2023)	research (library research)	been proven effective in improving learning outcomes and student engagement at various levels of education.	s evidence of the consistency of PBL's effectiveness based on the results of recent literature studies.
3	Literature Study: The Role of Problem-Based Learning (PBL) Model in Improving Students' Mathematical Problem-Solving Skills	Sawit Karlina & Rika Mulyati Mustika Sari (2024).	Elementary–High School Students	Literature study (content analysis of 5 journals)	PBL improves students' mathematical knowledge, skills, and problem-solving abilities. Proven to be consistently effective from the results of a review of 5 journals (2019–2024).	Provides a strong conceptual foundation that PBL is relevant for developing mathematical problem-solving skills.
4	Effectiveness of Video-Assisted Problem-Based Learning Model in Liveworksheets on Students' Mathematical Problem-Solving Students	Arghob Khofya Haqiqi & Sabila Nurus Syarifa (2021)	Skills Vocational High School	Quasi-experimental (pretest–posttest control group design)	Video-assisted PBL significantly improves problem-solving skills (N-Gain 0.63). Students are more active in understanding and evaluating the solution steps.	Demonstrates the effectiveness of digital media-based PBL, supporting the development of application-assisted PBL models.

No	Journal Title	Autors & Year	Subject	Method	Key Findings	Relevance to Reasearch
5	Analysis of the Implementation of Problem Based Learning Model on the Mathematical Problem Solving Ability of Junior High School Students (Jurnal Pendidikan dan Sains)	Nisa Rahmawati, et al. (2023)	Junior High School Students	Qualitative Descriptive	The application of PBL improves students' ability to understand problems and design contextual solutions. Learning activities are more collaborative and meaningful.	Relevant in the context of contextual learning, supporting the application of PBL in applied mathematics materials.
6	The Effect of Problem Based Learning Model Using Contextual Student Worksheet on Junior High School Students' Mathematical Problem Solving Ability	Ringki Agustinsa, Vesi Anjasari, & Nurul Astuty Yensy (2023)	Grade VII Students of SMP Negeri 12 Lebong	Quasi-experimental (One Group Pretest–Posttest Design)	The average score increased from 33.78 to 69.00. There was a significant effect (t count 14.3 > t table 2.07).	Confirming the effectiveness of PBL with contextual Student Worksheet to improve problem-solving ability.
7	Development of Scratch-Based Learning Media to Optimize Students' Problem Solving	Elis Nurhayati, Sinta Verawati Dewi, & Depi Setialesmana (2023)	7th grade students of SMP Tasikmalaya	R&D (PPE model)	Validation by material experts 88.09% (very valid), effectiveness 81.25%. Student response 90.73%	Supporting the use of PBL-based interactive digital media to improve problem solving skills.
8	Enhancing Mathematical Problem-Solving Skills	Li, Y. & Zhang, X. (2023)	High School Students in China	Mixed Methods Concurrent	PBL improves mathematical problem-	Supports global findings that PBL is

No	Journal Title	Autors & Year	Subject	Method	Key Findings	Relevance to Reasearch
	through Problem-Based Learning: An Experimental Study (Elsevier Journal)		Pure	Embedded type (primary qualitative and secondary quantitative)	solving performance by 32% compared to conventional classes. Significant positive effects on student learning motivation and engagement.	effective in improving problem solving and higher-order thinking skills.
9	Analysis of Problem Solving Ability in Problem Based Learning Model Accompanied by Remedial Teaching	Samsul Arifin, Kartono, & Isti Hidayah (2019), EduMa Vol. 8 No. 1 July 2019	Students of grade XI MIPA SMA N 1 Bojong, Tegal	Mixed Methods Concurrent Embedded type (primary qualitative and secondary quantitative)	Problem Based Learning (PBL) model accompanied by remedial teaching improves mathematical problem solving ability. Field independent cognitive style shows better results than field dependent. Diagnostic and remedial tests are effective in improving learning difficulties.	Relevant because it confirms the effectiveness of PBL in improving problem solving abilities. These results strengthen the theoretical argument that PBL has a positive effect on students' learning outcomes and critical thinking abilities, in accordance with the focus of your research on ethnomatics and technology-

No	Journal Title	Autors & Year	Subject	Method	Key Findings	Relevance to Reasearch
						based PBL.
10	Effect of The Application of The Problem Based Learning Model to The Mathematical Problem Solving Ability	Siska Ermayeni, Melisa, & Lucky Heriyanti Jufri (2020), EduMa Vol. 9 No. 1 July 2020	Students of class XI MIPA 1 SMAN 1 Sungai Limau	Pre-experiment (One Group Pretest-Posttest Design)	There is a significant effect of the application of the Problem Based Learning model on mathematical problem solving abilities. The average value increased from 48.10 (pretest) to 70.73 (posttest).	Relevant because it confirms the effectiveness of PBL in improving problem solving abilities. These results strengthen the theoretical argument that PBL has a positive effect on students' learning outcomes and critical thinking abilities, in accordance with the focus of your research on ethnomatics and technology-based PBL.

Table 2
Research Results

No	Researcher's Name	Research Results
1	Jurnal Edu-Mat (2022)	PBL has a positive effect with a medium-high effect size, improving students' mathematical problem-solving and collaborative skills.

2	Saravina P. R., Firda M. P., Zefi H. F., & Bambang E. S. (2024)	PBL has been proven effective in improving learning outcomes and student engagement at various levels of education.
3	Sawit Karlina & Rika Mulyati Mustika Sari (2024)	PBL consistently improves students' mathematical knowledge, skills, and problem-solving abilities.
4	Arghob Khofya Haqiqi & Sabila Nurus Syarifa (2021)	Video-assisted PBL in Liveworksheets improves problem-solving skills (N-Gain 0.63) and student learning activities.
5	Nisa Rahmawati, et al. (2023)	PBL improves the ability to understand problems and design contextual solutions; learning activities become more collaborative.
6	Ringki Agustinsa, Vesi Anjasari, & Nurul Astuty Yensy (2023)	There was an increase in the average score from 33.78 to 69.00 with a significant effect (t-test 14.3 > t-table 2.07).
7	Elis Nurhayati, Sinta Verawati Dewi, & Depi Setialesmana (2023)	Scratch-based media with a PBL approach was proven valid (88.09%), effective (81.25%), and received a positive response from students (90.73%).
8	Li, Y. & Zhang, X. (2023)	PBL improved mathematical problem-solving performance by 32% compared to conventional classes and increased learning motivation.
9	Samsul Arifin, Kartono, & Isti Hidayah	- The results of this study indicate that the application of the Problem-Based Learning (PBL) model accompanied by Remedial Teaching was deemed high-quality and effective in improving students' mathematical problem-solving abilities. - Providing diagnostic tests and remedial teaching effectively improves students' learning difficulties. - Students with a field-independent cognitive style have better problem-solving skills than field-dependent students. - Learning quality is assessed in terms of planning, implementation, and assessment.
10	Siska Ermayeni, Melisa, & Lucky Heriyanti Jufri	The results of the study show that the implementation of the Problem-Based Learning (PBL) model significantly improved the mathematical problem-solving skills of 11th-grade MIPA students at SMAN 1 Sungai Limau. - The average score increased from 48.10 (pretest) to 70.73 (posttest) after the implementation of PBL. - Students became better able to understand

	problems, plan solutions, and implement problem-solving strategies systematically. - PBL creates an active learning environment and improves students' critical thinking skills

Discussion

Based on the problem formulation raised in the method:

1. How can the Problem-Based Learning Model improve students' mathematical problem-solving skills?

The Problem-Based Learning (PBL) model improves mathematical problem-solving skills through a learning process that is oriented toward contextual problems and is student-centered.

According to constructivist theory (Arends, 2012; Hmelo-Silver, 2004), students construct their own knowledge through exploration, investigation, and reflection on real-world situations. The stages in PBL (1) problem orientation, (2) organizing students, (3) guiding the investigation, (4) presenting results, and (5) evaluating the process directly train students' mathematical problem-solving skills, as described by Polya (1957): understanding the problem, devising a plan, carrying out the plan, and looking back.

In mathematics learning, PBL encourages students to: understand the problem and identify important information, develop a solution strategy, test hypotheses and analyze the results, and reflect on and evaluate their thinking processes.

PBL also provides a space for students to collaborate, discuss, and relate mathematical concepts to everyday life. Through this process, students' conceptual understanding deepens, and their problem-solving skills significantly improve.

2. Is the Problem-Based Learning Model effective in improving students' mathematical problem-solving skills?

The literature review consistently shows that PBL is effective in improving students' mathematical problem-solving skills. This effectiveness is demonstrated by the following aspects:

a. Significant impact on learning outcomes.

All studies showed a significant increase in pretest–posttest scores. For example, research by Ermayani et al. (2020) showed an increase in average scores from 48.10 to 70.73 after implementing PBL.

b. Increased motivation and learning engagement.

PBL encourages students to be more active in learning, develops mathematical communication skills, and increases intrinsic motivation to understand concepts.

c. Effectiveness with the help of technology and contextual worksheets.

The use of media such as Scratch, interactive videos, and problem-based worksheets strengthens students' conceptual understanding, making the learning process more engaging and relevant to the real world.

d. Consistency across contexts and cultures.

Findings from international research by Sefa & Darko (2023) indicate that PBL is effectively implemented in various countries, including Indonesia, proving the model's universality.

Thus, the effectiveness of PBL lies not only in academic outcomes, but also in improving students' critical thinking, collaboration, and self-reflection skills, which are important parts of mathematical problem-solving abilities.

General Analysis of Previous Research Results

The literature review indicates that the Problem-Based Learning model is a learning approach oriented toward solving real-world problems as a means to develop mathematical problem-solving skills, fostering student creativity and collaboration. Nearly all articles in this review indicate that the implementation of PBL has a positive impact on learning outcomes. The first meta-analysis by the Edu-Mat Journal (2022) showed that the PBL model improved mathematical problem-solving skills with a moderate to high effect size. These results demonstrate the consistent effectiveness of PBL across various educational levels, from elementary to high school.

Furthermore, studies by Karlina & Sari (2024) dan Putri et al (2024), which focused on literature studies, also support similar findings. Both concluded that PBL can improve learning outcomes and student engagement in solving mathematical problems. These two articles are highly relevant to the objectives of the upcoming SLR, which is to systematically examine current empirical evidence regarding the effectiveness of PBL in improving mathematical problem-solving skills. A quasi-experimental article by Haqiqi & Syarifa (2021) provides a new dimension to the implementation of PBL by integrating digital media in the form of interactive videos and the Liveworksheets platform. The results of this study showed an increase in problem-solving ability scores with an N-Gain value of 0.63, which is in the medium-high category. This finding provides a new direction for SLR research, namely that the effectiveness of PBL can be strengthened through the use of multimedia-based learning technologies.

Research by N. U. Rahmawati et al. (2023) and Agustinsa et al (2023) provides concrete evidence of the implementation of PBL at the junior high school level. Through a qualitative and quasi-experimental approach, these two studies found that the implementation of PBL encouraged students to better understand problems, design problem-solving strategies, and enhance collaboration between students. The results of Ringki Agustinsa et al., which showed an increase in the average score from 33.78 to 69.00 with a significant difference (t-test 14.3 > t-table 2.07), confirmed that the contextual LKPD used in PBL is an effective tool for connecting mathematical concepts with real-world situations. In terms of media development, research by Elis Nurhayati et al. (2023) contributed by demonstrating the potential of Scratch-based media to optimize problem solving. With a validity rate of 88.09% and student responses reaching 90.73%, this study demonstrates that the integration of PBL and digital media can create engaging and meaningful learning. Research by Sefa & Darko (2023) in the international journal Elsevier strengthens global evidence that PBL improves mathematical problem-solving performance by up to 32% compared to conventional classes. This positive effect is also

evident in aspects of student learning motivation and engagement. These results demonstrate that the effectiveness of PBL is universal and cross-cultural, making it applicable in various educational contexts, including in Indonesia.

Relationship to the SLR "Mathematical Problem-Solving Ability with the PBL Model"

All previous research reviewed indicates that the variables of mathematical problem-solving ability and the Problem-Based Learning model have a very close and mutually reinforcing relationship. In the context of the SLR to be compiled, these articles provide several key points of synthesis as follows:

Consistent Empirical Basis: All articles demonstrate the positive influence of PBL on mathematical problem-solving ability, using both quantitative and qualitative methods, as well as literature studies. This strengthens the argument that this SLR has a solid empirical basis.

Related to Constructivism Theory: PBL places students at the center of learning and the teacher as a facilitator. This aligns with the principles of constructivism, which emphasize that knowledge is built through learning experiences and reflection on real-world problems.

Integration of Technology and Contextual Media: Several studies demonstrate the effectiveness of PBL enhanced by the use of digital media. In the SLR, this aspect will be an additional focus of discussion: the extent to which technology supports the implementation of PBL to enhance problem-solving in the digital learning era. Impact on Motivation and Learning Independence: Several studies also indicate that PBL increases motivation and learning independence. This is relevant to the planned development of the SLR theme, which not only examines problem-solving abilities from a cognitive perspective but also their relationship to students' affective and mathematical dispositional aspects.

Consistency Across Educational Levels and Contexts: Research results indicate that the effectiveness of PBL is not limited to a specific level. In the SLR, this will serve as a basis for mapping the scope and range of PBL implementation at various educational levels.

Synthesis of Discussion

Overall, the results of the eight articles analyzed indicate that PBL is an effective and relevant learning model for improving students' mathematical problem-solving abilities. The findings from previous research strengthen the conceptual framework of the upcoming SLR, namely that problem-solving abilities are not simply the result of procedural practice, but are formed through a process of exploration, discussion, and reflection facilitated by PBL.

Therefore, the SLR article, entitled "Mathematical Problem-Solving Ability with the Problem-Based Learning Model," will focus on a systematic synthesis of various research findings demonstrating how the application of PBL can improve mathematical problem-solving abilities, strengthen collaborative skills, and integrate real-world contexts into mathematics learning.

CONCLUSION

The results of a systematic literature review indicate that the application of Problem-Based Learning (PBL) in mathematics learning has a very significant impact on students' mathematical problem-solving abilities at various levels of education (elementary, middle, and high school). All studies demonstrated a significant positive impact on improving learning outcomes, mathematical problem-solving abilities, and collaborative skills. PBL aligns with constructivist theory, where knowledge is acquired through experience and solving real-life problems. A learning process that places students at the center of the activity allows for meaningful and in-depth learning. Based on the results and discussion above, it can be concluded that:

The Problem-Based Learning model can improve students' mathematical problem-solving abilities because it places students at the center of learning and encourages them to think critically and creatively, and apply mathematical concepts in real-life contexts. PBL allows students to systematically progress through problem-solving stages in accordance with Polya's theory.

The Problem-Based Learning model is effective in improving students' mathematical problem-solving abilities at various levels of education (elementary to high school). All research results show significant improvements in students' learning outcomes, motivation, and learning independence. The integration of learning technologies such as Liveworksheets, Scratch, and interactive videos further strengthens the effectiveness of this model.

Overall, PBL is a comprehensive, contextual, and relevant learning model for the needs of the 21st century. This model is capable of developing students' mathematical problem-solving skills, higher-order thinking, and collaborative character, in line with the vision of sustainable education (SDGs point 4: Quality Education).

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