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Problem-Based Learning Methods In Mathematics Courses: Systematic Literature Review

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ABSTRACT
The purpose of this study is to determine and explain the impact of problem-based learning models on mathematical Learning, specifically in achieving mathematical learning goals. The method used in this study is a systematic literature review approach. From the results of the search strategy, 200 articles were identified from 2010 to 2021 and were systematically selected to include 10 articles related to the topic of problem-based learning models in mathematics. The results of this study show that the impact of problem-based learning models on mathematics learning is significant. It shows that 10 tested articles can answer research questions. In other words, (1) How are mathematical learning goals achieved based on the results of reviews of research articles on problem-based learning models? (2) Do problem-based learning models affect the achievement of mathematics learning goals? The results of these articles show an increase in the construction of mathematics learning goals after the implementation of problem-based learning models in mathematics. This means that (1) increases students' cognitive skills, (2) improves problem-solving capabilities, (3) increases student learning outcomes, and (4) increases student growth. These results demonstrate that problem-based learning models have an impact on mathematics learning.

Keywords
Problem-Based Learning, Match, systematic literature review

INTRODUCTION

Mathematics is a crucial topic that requires exploration as the fundamental basis of the structure of mathematical Knowledge (Lidinilah et al., 2015). By this, Dahlia, Pranata, and Suryana (2020) demonstrate that learning mathematics should be taught to teachers as a process that involves the ability to think logically, analytically, systematically, critically, and collaboratively.

According to the Ministry of Education and Culture, Rami et al. (2016) are, the goals of mathematics formation (1) improving teachers' cognitive skills, (2) supporting teachers to solve problems, (3) improving teachers' learning outcomes, (4) improving teachers' ability to communicate ideas, and (5) developing characters. Teacher results. This is evidenced by the results of the February study by Haryanti and Komalasari (2018). This suggests that mathematics teachers often still play a passive role in problem-solving. Mathematics learning is still considered low as educators continue to use traditional learning models, and teachers do not play an active role in the classroom (Kurino, 2020b). This indicates that the learning model used is not effective and is not suitable for achieving the mathematical goal.

The solution to this problem is to select the appropriate learning model in mathematics education and to motivate teachers to learn mathematics. The most effective learning model for achieving mathematics learning goals is the problem-based learning model. According to Rahman (2018), the problem-based learning model involves teachers who play an active role in systematically solving problems according to the stages of the scientific method, allowing students to understand and

solve problems from their roots.

Problem-based learning models are learning models that provide authentic, positive experiences, motivating teachers to build knowledge and naturally integrate school learning contexts into everyday life (Arnidha, Noerhamalina, & Rekawati, 2018). Therefore, problem-based learning models can be chosen for use in the learning process, especially in the formation of the mathematics compartment, as this model aligns with the goals of the mathematics compartment, particularly in improving cognitive skills, problem-solving, and learning outcomes.

To scientifically demonstrate that problem-based learning models impact the achievement of mathematical learning goals, this study draws on a range of previous research findings related to the topic of this study. Therefore, an appropriate research method is a systematic literature overview, according to Gough et al. Zawacki-Richter et al. (2020) define a systematic literature search as a review of existing research using rigorous and structured research methods to address specific research questions. The research source used in this study is a journal article related to the topic of problem-based learning models in mathematical formation.

METHOD

This study employs a systematic literature review, which involves a data collection process that corresponds to the systematic literature search research procedure. According to Zawacki-Richter et al. (2020) is the design of a systematic literature overview research procedure as follows:

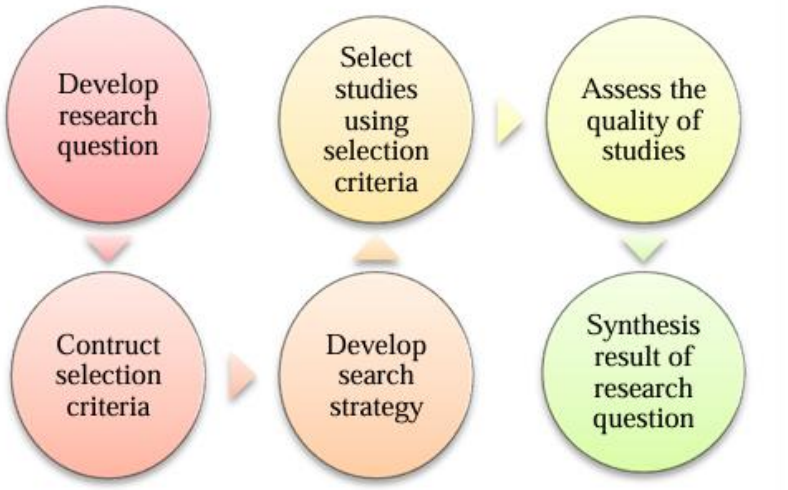

Figure 1. (Diagram of the systematic literature review procedure (Zawacki-Richter et al., 2020)

The research questions developed in this study are as follows:

RQ1. How is the achievement of mathematics learning objectives based on the results of a review of research articles
On the Problem-Based Learning model?

RQ2. Does the Problem-Based Learning model affect the achievement of mathematics learning objectives?

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The selection criteria for this study are shown in the following table

Table 1. Inclusion and Exclusion Criteria

Inclusion criteria (acceptance)	a. According to the research topics of Problem-Based Learning Models (PMB) or Problem-Based Learning Aspiration (PBL). b. Publications (2010-2021). c. Full text
Exclusion criteria (denial)	a. Journal of research or scientific research other than research topics. b. Published before 2010. c. Unparalleled text t

Source: processed by researcher, 2025

The search was conducted using a web browser (Google Chrome) to access the websites http://garuda.ristekdikti.go.id and https://scholar.google.com/. To narrow down the results and avoid an excessive number of irrelevant articles, more specific search terms were used. The initial screening involved reviewing the titles and abstracts of the retrieved articles to determine their relevance to the study (Zawacki-Richter et al., 2020). In the context of a systematic literature review (SLR), each selected article undergoes a quality assessment based on the following criteria: QA1. Is the journal article listed in Sinta? QA2. Does the paper address a research problem related to this study?QA3. Does the article employ research methods applicable to the development of a problem-based learning model? Each article is then evaluated against these questions and marked accordingly as 'Y' (Yes) or 'T' (No).

RESULT AND DISCUSSION

1. Develop research question

The search strategy applied to the websites https://garuda.ristekbrin.go.id and https://scholar.google.com, using the specified search terms, initially retrieved 200 articles. However, after removing 30 duplicate entries based on titles and authors, a total of 170 unique articles remained for further analysis.

2. Selection criteria

After applying the inclusion and exclusion criteria to the 170 articles, 53 were identified as meeting all the specified inclusion requirements. These criteria included (1) focusing on problem-based Learning (PBL) or problem-based Learning (PBM) in elementary school mathematics, (2) being published between 2010 and 2021, and (3) being available in full-text format. A total of 117 articles were excluded for the following reasons: 48 did not align with the topic of PBL or PBM in mathematics, nine were published outside the target time range (before 2010), and 60 were excluded due to incomplete content, with only abstracts available.

3. Developing the Search Strategy

At this stage, articles that met the initial inclusion criteria were reviewed first by title and then by abstract to assess their relevance to the research topic. Based on this screening process, 30 articles were deemed relevant, while 23 were found to be unrelated to the study. Articles were classified as irrelevant if the educational level was not specified in the title, and the abstract did not mention the educational context, making them unsuitable for the scope of this research.

4. The Study Selection Process

The results of the quality assessment indicated that 10 journal articles fulfilled all the predefined quality criteria, as reflected by positive responses to all evaluation questions (QA1, QA2, QA3). This confirms that these articles were published in Sinta-indexed journals, addressed research problems relevant to problem-based learning models in mathematics education, and provided clear descriptions of the research methods used in developing such models.

5. Appraising the Quality of Studies

The next step in the research process is data synthesis. The purpose of this stage is to gather and analyze evidence from the selected studies in order to address the research questions (Latifah & Ritonga, 2020). Below are the research questions (RQ) and corresponding findings: RQ1: How is the achievement of mathematics learning objectives based on the rsults of a review of research articles on the Problem-Based Learning (PBL) model? Based on the analysis of 10 selected journal articles, it was found that the PBL model contributes effectively to achieving mathematics learning objectives in elementary school settings. This is supported by improvements observed in pre- and post-intervention scores or percentages. In general, there was a noticeable increase in student performance after implementing the PBL approach.

RQ2: Does the Problem-Based Learning model influence the achievement of mathematics learning objectives in elementary schools? To assess the impact of the PBL model on mathematics learning outcomes, reference was made to the indicators defined by the Ministry of Education and Culture, as cited in Rahmi et al. (2016), and findings from the reviewed literature.

One of the key goals of mathematics education is to enhance students' cognitive abilities. The data revealed that prior to the implementation of the PBL model, the average score was 67.35 with a student achievement percentage of 45.11%. After implementation, these figures increased to an average score of 84.73 and an achievement percentage of 85%, indicating a positive effect of the PBL model on students' cognitive development.

Another core objective of mathematics instruction is improving problem-solving skills. The reviewed studies showed an improvement in this area as well, with the average increasing from 63.61 to 80.6. These results support the conclusion that the PBL model positively influences mathematics learning in elementary schools, particularly in enhancing problem-solving capabilities.

The third objective of mathematics education is to enhance student learning outcomes. The data revealed improvements in this area following the implementation of the Problem-Based Learning (PBL) model. Before its application, the average score was 56.35, with a student achievement rate of 41.48%. After implementation, these figures increased to an average score of 79.39 and an achievement rate of 76.82%. These results indicate that the PBL model positively influences student performance in mathematics.

The fourth objective focuses on improving students' ability to communicate their ideas effectively. The findings showed a significant increase in this skill, with the average percentage of student achievement rising from 47.7% to 79.5% after the PBL model was introduced. This suggests that the PBL approach enhances students' capacity to articulate mathematical concepts and reasoning.

The final objective examined was the development of students' character, particularly their creative and critical thinking abilities, as outlined in the selected studies. The data indicated an improvement in this domain, with the average score increasing from 60.39 (48.72% achievement) to 77.85 (87.18% achievement) after the implementation of the PBL model. These findings confirm that the PBL approach has a positive impact on character development in elementary school mathematics, especially in fostering creative and critical thinking skills.

Discussion

This research fundamentally affirms the superiority of the Problem-Based Learning (PBL) model, which is deeply rooted in the theory of constructivism. In contrast to traditional pedagogical approaches that often position students as passive recipients of information (Ali & Hukamdad, 2021), constructivism emphasizes that knowledge is actively constructed by the learner through experience and social interaction (Widiara, 2022). The findings of this study, which demonstrate increased student activity and autonomy, are a practical manifestation of this principle, wherein PBL acts as a catalyst for student-driven Learning (Gorghiu & Santi, 2023). This process transforms the role of the teacher from the primary source of knowledge to a facilitator of Learning, a crucial shift proven to enhance deep conceptual understanding (Nurhadi et al., 2024). Consequently, PBL creates an authentic learning ecosystem where knowledge is not merely transferred, but is collaboratively and contextually constructed by the students themselves (Astuti & Wijaya, 2023).

The success of PBL in enhancing various competencies can be further elucidated through the concept of Situated Learning and the stimulation of Higher-Order Thinking Skills (HOTS). The theory of Situated Learning posits that Learning becomes more effective when it is embedded in the context of authentic, real-world problems, which significantly increases student motivation and engagement (Sumartini & Handayani, 2022). The increase in scores for problem-solving and critical thinking abilities in this research indicates a shift from merely remembering and understanding (Lower-Order Thinking Skills, or LOTS) to the ability to analyze, evaluate, and create (HOTS), which is a primary focus of modern curricula (Pratama & Istiyono, 2021). The implementation of PBL has been consistently proven effective in cultivating these HOTS, particularly within the complex domain of mathematics (Lestari & Annizar, 2023). This process requires students to continuously connect new concepts with existing knowledge to formulate innovative solutions (Sari & Misu, 2024), ultimately building cognitive fluency and superior reasoning abilities (Putra & Mampouw, 2023).

Overall, the synthesis of evidence from these ten articles provides robust empirical validation that PBL effectively and holistically transforms the achievement of mathematics learning objectives. The quantitative data, showing significant improvements across various indicators, confirms that PBL successfully shifts the paradigm from teacher-centered instruction to student-centered Learning (Jaelani et al., 2023). This success is not confined to the cognitive domain but also encompasses the development of affective and social skills essential for the 21st century (Rachman & Setiawan, 2022). Thus, these findings provide an evidence-based justification for policymakers and educational practitioners to prioritize the

adoption of PBL as a superior pedagogical model (Simamora, 2021). The implementation of this model represents a strategic investment in equipping students with competencies in problem-solving, critical thinking, and lifelong self-directed Learning (Surur et al., 2024), thereby addressing the educational challenges of the current era of digital disruption (Effendi & Kurniati, 2023).

CONCLUSION

The systematic literature review conducted on problem-based learning (PBL) models in elementary school mathematics education reveals that the implementation of this approach has a positive impact on various aspects of student learning. Analysis of the selected journal articles indicates that the PBL model contributes to the achievement of mathematics learning objectives, particularly through improvements in students' cognitive abilities, problem-solving skills, and overall academic performance. Additionally, the model supports the development of effective communication skills and character growth, including critical and creative thinking. These findings collectively demonstrate that problem-based Learning enhances the teaching and learning process in mathematics at the elementary school level.

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