



Junior High School Students' Mathematics Problem-Solving Ability Using the Problem-Based Learning Model: A Systematic Review

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Abstract

Purpose: This study aims to examine the ability of junior high school students to solve mathematical problems through the application of the Problem-Based Learning (PBL) model. **Methodology:** The research method used in this study is a systematic literature review. Researchers searched for journal articles on junior high school students' mathematical problem-solving ability using the Problem-Based Learning model. The search was conducted through the Google Scholar database, and the Publish or Perish application was used. **Findings:** Based on the analyzed articles, it can be concluded that the Problem-Based Learning model improves students' mathematical problem-solving skills. This is supported by the increase in students' skills before and after implementation. **Significance:** This research is expected to serve as a reference for teachers and researchers interested in improving mathematical problem-solving skills using the Problem-Based Learning model.

Keywords: junior high school, problem-based learning, problem-solving, systematic review.



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Introduction

Problem-solving ability in mathematics benefits students' academic achievement and equips them with skills to overcome challenges in life (Yapatang & Polyiem, 2022). It is considered the core of mathematics teaching and learning (Liljedahl et al., 2016). Problem-solving is a crucial aspect of mathematics teaching and learning. It is considered a basic skill that students must develop and master. The importance of problem-solving is evident in the fact that it is the core and center of the mathematics curriculum, encompassing methods, procedures, and strategies (Ince, 2018). Permana (2023) emphasizes the significance of problem-solving ability for students. Therefore, it is essential to focus on developing and enhancing students' problem-solving skills.

In Mathematics Education, the term 'problem solving' refers to 'mathematical tasks that have the potential to provide intellectual challenges to enhance students' mathematical understanding and development' (NCTM, 2000). Problem solvers use this principle to process problems and apply mathematical methods (Yapatang & Polyiem, 2022). Mathematical problem-solving activities require students to apply learned mathematical concepts in various problem situations (Suseelan et al., 2022).

Mathematics is a core subject in the school system, closely related to problem-solving (Zhou et al., 2019). The primary objective of learning mathematics is to develop students' ability to solve complex problems (Fernandez et al., 1994). To strengthen this foundation, learning models have become a significant focus of study. Project-Based Learning (PBL) has emerged as an innovative solution. PBL is an approach that encourages students to develop problem-solving skills through real and applicable learning experiences. It is not just a learning method.

Problem-Based Learning (PBL) is an educational approach that uses real-life problems as a context for students to develop critical thinking and problem-solving skills while gaining a deeper understanding of the subject matter (Anwar & Jurotun, 2019). According to Barrows in Madyaratri et al. (2021), PBL is a learning model that necessitates students to collaborate in the problem-solving process. Problems are presented at the beginning of the learning process, allowing students to actively apply their knowledge. The teacher's role is solely that of a facilitator. Indah et al. (2016) and Pamungkas et al. (2019) also found similar results, indicating that students who participated in learning with PBL achieved better mathematical literacy skills compared to those who participated in conventional learning.

The significance of utilizing Problem-Based Learning (PBL) to enhance problem-solving abilities not only affects individual achievement but also has significant implications for the overall advancement of education. Therefore, this study aims to make a substantial contribution to our understanding of how the Project-Based Learning Model can enrich the development of students' problem-solving skills in educational institutions. A literature study was conducted to investigate mathematical problem-solving skills using the Problem-Based Learning (PBL) Model.

Method

This study employs the Systematic Literature Review (SLR) methodology. SLR is an approach to reviewing current literature in a structured, transparent, and reproducible manner at each stage to comprehensively identify and assess related research (Higgins et al., 2011; Hidayat & Wardat, 2023). The aim of this approach is to identify and review journals that follow established steps in each process. The purpose of conducting an SLR study is to examine, identify, evaluate, analyze and interpret all selected

studies, focusing on the research questions. Figure 1 shows the steps involved in conducting a systematic review, as outlined by Bicer (2021).

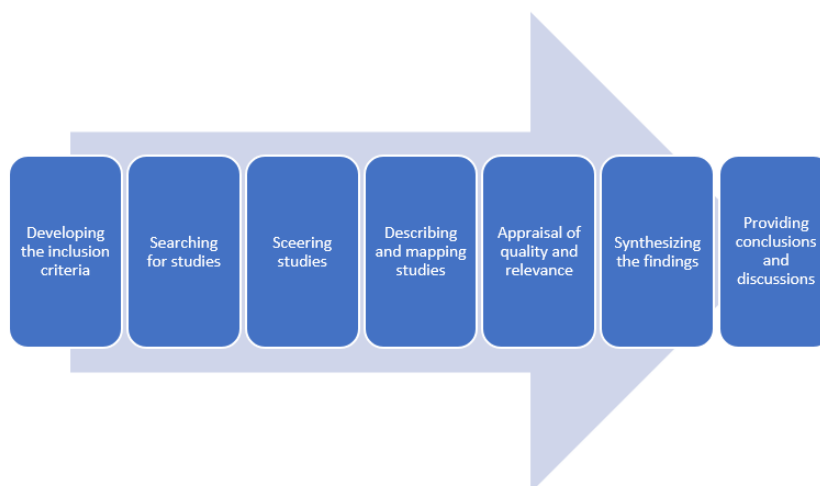


Figure 1. Systematic review steps (Bicer, 2021)

Based on the research methodology described above, researchers conducted a document search for journal articles using the keywords 'mathematical problem-solving ability of junior high school students in the context of Problem-Based Learning'. The search was conducted through the Google Scholar database using the Publish or Perish application. Initially, hundreds of articles were found that were generally in line with the research objectives. However, the initial selection of journals for review did not include articles that were specifically relevant. This limitation was necessary to focus the research and ensure a comprehensive examination in this study.

After conducting the search, the researcher assessed the results and selected articles that met the specific criteria for the study. The literature criteria included: (1) The article focuses on the mathematical problem-solving ability of junior high school students using a problem-based learning model. (2) Only articles published between 2013 and 2023 were included. (3) Articles must be written in Indonesian. (4) Only articles published in Indonesian journals indexed nationally in SINTA 1-4 will be considered. (5) The research must be in the field of mathematics education. By adhering to these criteria, we can provide objective information and evidence on the impact of the Problem-Based Learning (PBL) model on the problem-solving skills of junior high school students.

Results and Discussion

The mathematics learning process in Indonesia follows a student-centered curriculum, which includes the Problem-Based Learning (PBL) model. According to Arends in Silalahi et al. (2021), PBL is intended to enhance students' thinking, problem-solving, and intellectual skills. According to Ulva et al. (2020), mathematical problem-solving abilities are considered the heart of mathematics learning. An interactive learning model for both students and teachers can have a positive impact on student engagement. This literature review presents a research analysis of articles published on Google Scholar and Publish and Perish related to junior high school mathematical problem-solving abilities in the problem-based learning model. Table 1 provides a summary of the identified research types and methods.

Table 1. *The Researcher's Data and Types of Research Used in the Selected Articles*

No.	Authors	Types and Methods of Research
1	(Yerizon, Wahyuni, & Fauzan, 2021)	Quantitative: Experiment
2	(Yunarni, 2018)	Quantitative: Experiment
3	(Putri, Suryani, & Jufri, 2019)	Quantitative: Experiment
4	(Sulaeman & Ismah, 2016)	Qualitative
5	(Monica, Kesumawati, & Septiati, 2019)	Quantitative: Experiment
6	(Yanti, 2017)	Quantitative: Experiment
7	(Ulva, Maimunnah, & Murni, 2020)	Quantitative: Experiment
8	(Lestari, Dwijanto, & Hendikawati, 2016)	Quantitative: Experiment
9	(Nadhifah & Afriansyah, 2016)	Quantitative: Experiment
10	(Elita, Habibi, & Ulandari, 2019)	Quantitative: Experiment
11	(Yustianingsih, Syarifuddin, & Yerizon, 2017)	Design Research: Plomp 3-Phase
12	(Novianti, Yuanita, & Maimunah, 2020)	Action Research
13	(Rinaldi & Afriansyah, 2019)	Quantitative: Experiment
14	(Reski, Hutapea, & Saragih, 2019)	Qualitative
15	(Albab & Sumaji, 2021)	Qualitative
16	(Setiani, Lukman, & Suningsih, 2020)	Action Research
17	(Marlina, Nurjahidah, Sugandi, & Setiawan, 2018)	Action Research
18	(Nuraini, Maimunah, & Roza, 2020)	Design Research: 4-D model
19	(Abdullah, Mastur, & Sutarto, 2015)	Quantitative: Experiment

According to Table 1, the researchers utilized various research methods, including quasi-experimental quantitative, descriptive qualitative, descriptive quantitative, Classroom Action Research (CAR), quantitative experimental, and development model methods. Out of the 20 articles included in the study, 13 employed quantitative research methods, with the majority utilizing quasi-experimental designs. Two articles used development models, two were qualitative, and three were Classroom Action Research (CAR). [Yustianingsih et al. \(2017\)](#) conducted research using the Plomp 3-phase model: preliminary research (preparation), prototyping phase (design), and assessment phase (evaluation). Similarly, [Nuraini et al. \(2020\)](#) utilized the 4-D Thiagarajan and Semmel development model, which includes define (definition), design (design), develop (development), and disseminate (dissemination) stages. [Novianti et al. \(2020\)](#), [Setiani et al. \(2020\)](#), and [Marlina et al. \(2018\)](#) employed Classroom Action Research (CAR) through four stages: planning, implementation, observation, and reflection. The research was typically carried out through cycles and predetermined Minimum Mastery Criteria (KKM) before being conducted.

Table 2. Data from Problem-Based Learning Research at SMP/MTs Level

No.	Authors	Conclusion
1	(Yerizon, Wahyuni, & Fauzan, 2021)	Students who study using the Problem-Based Learning model exhibit higher problem-solving abilities compared to those who use the conventional model.
2	(Yunarni, 2018)	The application of the Problem-Based Learning model has a positive and significant impact on students' mathematical problem-solving abilities.
3	(Putri, Suryani, & Jufri, 2019)	The data analysis results indicate that Problem-Based Learning has a positive impact on students' mathematical problem-solving abilities.
4	(Sulaeman & Ismah, 2016)	The implementation of the Problem-Based Learning strategy has resulted in improved mathematical problem-solving abilities among students at each meeting.
5	(Monica, Kesumawati, & Septiati, 2019)	Based on the data analysis and discussion, it can be concluded that the Problem-Based Learning model has a greater positive impact on the mathematical problem-solving abilities of junior high school students in Gelumbang District compared to conventional learning.
6	(Yanti, 2017)	Students taught using the problem-based learning model exhibit better mathematical problem-solving abilities than those taught using conventional models.
7	(Ulva, Maimunnah, & Murni, 2020)	The application of the Problem-Based Learning model has continued to positively influence mathematical problem-solving abilities, despite the impact of the Covid-19 outbreak.
8	(Lestari, Dwijanto, & Hendikawati, 2016)	The effectiveness of the Problem-Based Learning model on the mathematical problem-solving abilities of seventh-grade students at SMP Negeri 41 Semarang in fulfilling the KKM, both individually and collectively.
9	(Nadhifah & Afriansyah, 2016)	The Problem Based Learning learning model has been shown to significantly improve students' mathematical problem-solving abilities.
10	(Elita, Habibi, & Ulandari, 2019)	Student learning outcomes using the Problem-Based Learning model exhibit greater mathematical problem-solving abilities compared to conventional learning models.
11	(Yustianingsih, Syaritudin, & Yerizon, 2017)	The use of Problem-Based Learning (PBL) in the development of Lesson Plan (LKPD) and Lesson Implementation Plan (RPP) has yielded valid, effective, and practical results in enhancing the mathematical problem-solving abilities and learning activities of eighth-grade students at SMPN 3 Sawahlunto.
12	(Novianti, Yuanita, & Maimunah, 2020)	The Problem Based Learning model enhances the mathematical problem-solving skills of class VII-2 students at SMPN 9 Pekanbaru in Algebra Form material.

No.	Authors	Conclusion
13	(Rinaldi & Afriansyah, 2019)	The Problem Based Learning model was used to enhance the mathematical problem-solving skills of eighth-grade students at SMP Negeri 4 Tarogong, resulting in moderate improvement.
14	(Reski, Hutapea, & Saragih, 2019)	The problem-solving abilities of students at SMP Negeri 4 Padang Bolak are relatively low. Positive improvements were found in these students after implementing the PBL model, which were classified as moderate.
15	(Albab & Sumaji, 2021)	The Problem Based Learning model, aided by the Gagung Duran application, has resulted in a significant improvement in students' problem-solving abilities compared to the conventional learning model in class VIII SMP 1 Mejobo.
16	(Setiani, Lukman, & Suningsih, 2020)	There has been an improvement in students' ability to solve mathematical problems after using the Problem-Based Learning model.
17	(Marlina, Nurjahidah, Sugandi, & Setiawan, 2018)	Classical completeness increased from Cycle I to Cycle II, with 62% in Cycle I and 82% in Cycle II. This demonstrates that PBL can enhance the mathematical problem-solving abilities of Class VII students at MTs Muslimin Tanjungwangi when using scale and comparison material.
18	(Nuraini, Maimunah, & Roza, 2020)	PBL tools can enhance the mathematical problem-solving skills of seventh-grade junior high school students in social arithmetic.
19	(Abdullah, Mastur, & Sutarto, 2015)	The use of the ethnomatics-based Problem-Based Learning model is considered effective in enhancing the problem-solving skills of eighth-grade students at SMPN 1 Demak.

According to Table 2, the majority of research on the application of Problem-Based Learning (PBL) to enhance the mathematical problem-solving skills of middle school students yielded positive results. This indicates that the use of the PBL model in mathematics education can enhance students' mathematical problem-solving abilities, as evidenced by an increase in their skills before and after implementation. Cotton's opinion suggests that Problem-Based Learning can promote critical thinking and problem-solving skills among students (Sulaeman & Ismah, 2016). Research supports the effectiveness of the PBL model over conventional models in improving problem-solving (Yerizon et al., 2021; Monica et al., 2019; Yanti, 2017; Albab & Sumaji, 2021). The Problem-Based Learning model, supported by interesting learning media, can improve problem-solving skills, as demonstrated by research (Nuraini et al., 2020; Abdullah et al., 2015; Albab & Sumaji, 2021; Ulva et al., 2020). The study by Abdullah et al. (2015) is particularly noteworthy as it connects local culture to mathematics learning through ethnomatics. Improving problem-solving skills using the PBL model in research has yielded valid, effective, and practical results, as demonstrated by Yustianingsih et al. (2017) in accordance with the 3 Phase Plomp development model. Additionally, Marlina et al. (2018) conducted research using the PTK design and found that completion in cycle II exceeded the specified KKM, reaching 82%.

Conclusion

Based on the data analysis described above, it is evident that the Problem-Based Learning model can enhance students' mathematical problem-solving abilities. This is supported by the increase in students' mathematical problem-solving abilities before and after the implementation of the model. Thus, these research findings can serve as a reference for teachers and researchers, particularly regarding enhancing mathematical problem-solving skills through the Problem-Based Learning (PBL) model. Future researchers are encouraged to identify gaps in this study and broaden their sources of relevant literature. Apart from that, teachers can apply the findings by using learning materials that support PBL in their classes.

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