

Systematic Literature Review: APPLICATION OF PROBLEM-BASED LEARNING MODELS TO IMPROVE MATHEMATICAL CREATIVE THINKING ABILITIES

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Abstract (English)

In 2022, the Program for International Student Assessment (PISA) conducted a global creativity survey, revealing that Indonesian's mathematical literacy ranks in the low category. To address this issue, enhancing student's creativity skills in mathematics education is essential. One potential strategy is the application of problem-based learning models. This study aims to re-examine the effectiveness of problem-based learning in fostering students' mathematical creative thinking skills. The research employs a systematic literature review approach, with data gathered from articles and research journals related to mathematical creative thinking and problem-based learning. The data sources are limited to studies published between 2020 and 2024.

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Key Words

Creative Thinking Skills,
Problem-Based Learning.

1. Introduction

Mathematics is a discipline essential to science and technology, acting as a foundational tool for applying concepts across various fields and supporting its own advancement. In the 21st century, fostering creative thinking in mathematics has become a critical skill for students. According to studies by Zakiah et al. (2020) and Septikasari (2018), 21st-century skills encompass creative, critical, communicative, and collaborative thinking, all of which are crucial for addressing real-world challenges. To effectively solve mathematical problems, students require creative thinking abilities that enable them to develop their own understanding by formulating, interpreting, solving models, or planning solutions.

One of the goals of national education by Permendikbud is to make students creative. To realize this, there are still obstacles, obstacles to mathematical creative thinking skills can be caused by several factors. One of the main factors is a lack of conceptual understanding, where students may understand mathematical procedures but do not understand the concepts behind them. In addition, the learning environment is less supportive, such as an approach that is too rigid or a lack of opportunities for collaboration and discussion. To overcome these obstacles, it

is important for teachers to create a learning environment that stimulates creativity, provides time for exploration, and encourages a deep understanding of mathematical concepts.

Educational programs in many countries aim to increase mathematical creative thinking to develop the next generation of innovators (Suherman and Vidákovich, 2022). Creative thinking is a person's ability to innovate in creating new things to help themselves achieve a goal. The ability to think aims to create new opinions that do not yet exist, are unusual, and original with the right results (Rahayu: 2022). So the ability to think mathematically creatively is a skill that is needed during mathematics learning activities.

Problem-based learning model is a learning model that shapes student progress so that they have expertise in solving a problem in student learning activities and can encourage students to develop thinking skills to be more critical (Nuarta, 2020). In problem-based learning, there is a general conceptual fog, including a combination of educational methods and curriculum philosophy. In terms of philosophy, problem-based learning is centered on students who are faced with a problem. While in subject-based learning, it means that before using problems as a basis for learning, teachers can provide illustrations of the knowledge.

In mathematics learning, students are often faced with difficulties in solving complex problems or problems that are rarely encountered (Nurkamilah & Afriansyah, 2021). Therefore, in solving these problems, creative thinking skills are needed.

Creative thinking skills in mathematics include the ability to solve problems or construct thoughts in structures, express statements that are different from ordinary deductive logic, and put forward general concepts to unite important things in mathematics (Widiyanto & Yunianta, 2021).

Creative thinking skills enable students to comprehend, master, and address the challenges they encounter. When solving problems, students are encouraged to generate innovative ideas or creative solutions, allowing them to analyze and resolve issues effectively and arrive at appropriate solutions.

According to Munandar (Syifa Annisa, A et al 2023), indicators of creative thinking ability with creative thinking characteristics

Inclusive Criteria	Exclusive Criteria
Articles published from 2020-2024	Articles published outside of 2020-2024
Mathematical creative thinking ability article	Articles beyond mathematical creative thinking skills
Problem-based learning model article	Articles outside the problem-based learning model

Table 2. Inclusive and exclusive criteria

2. Method

This study employs the Systematic Literature Review (SLR) method, which involves systematically identifying, reviewing, evaluating, and interpreting existing research. The SLR approach requires a structured review process, ensuring that each step follows predetermined guidelines for identifying and analyzing relevant journals.

2.1 Research Questions

Research questions are questions designed to guide investigation or research on a particular topic. These questions form the basis for formulating hypotheses, collecting data, and analyzing findings. Research questions are typically specific, focused, and can be answered through systematic research methods.

RQ 1. In what ways can implementing problem-based learning enhance students' creative thinking skills in mathematic?

RQ 2. Do students who engage in problem-based learning demonstrate different levels of mathematical creative thinking compared to those who participate in conventional learning methods?

RQ 3. How effectively can problem-based learning enhance students' motivation to learn mathematic?

2.2 Search Process

This study sourced journal articles from Google Scholar using the Publish or Perish application with keywords like "mathematical creative thinking skills" and "problem-based learning." The research process involved multiple stages, including developing research questions, conducting literature searches, setting inclusion and exclusion criteria, presenting and analyzing data, and ultimately drawing conclusions.

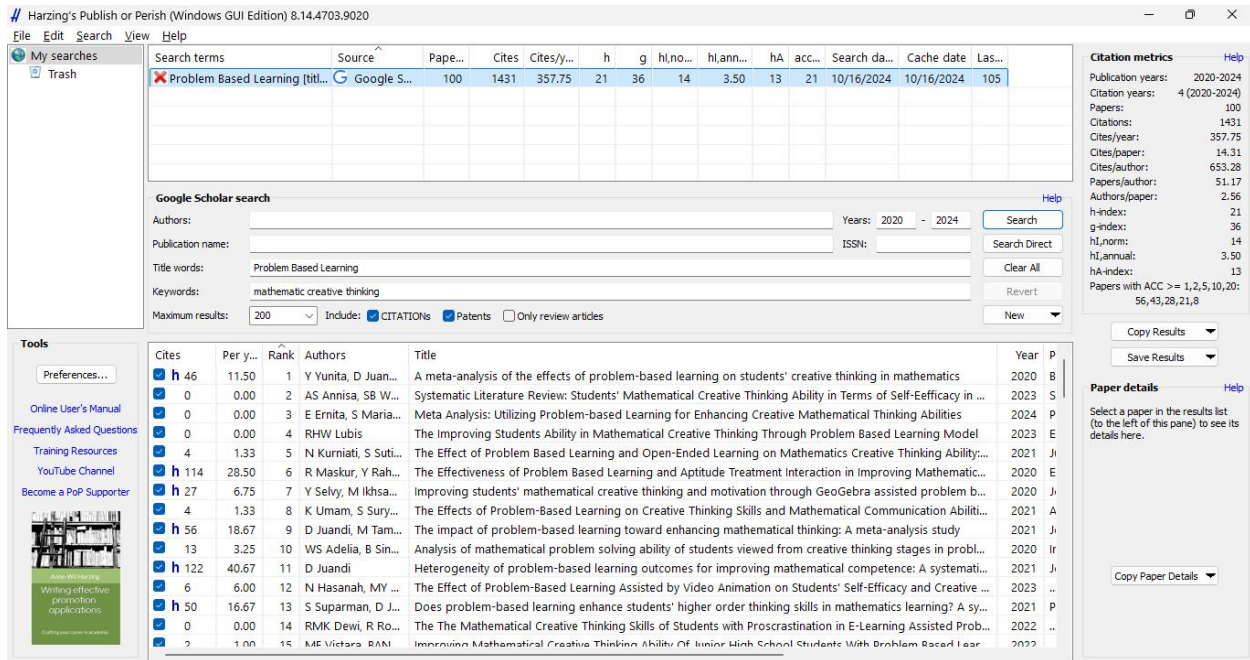


Figure 1. Publish or Perish Results

Inclusive Criteria	Exclusive Criteria
Articles published from 2020-2024	Articles published outside of 2020-2024
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Table 2. Inclusive and exclusive criteria

A total of 31 articles were collected from various sources and subsequently subjected to identification, review, evaluation, and interpretation. From this process, 8 articles were selected that met the specified criteria.

3. Results and Discussion

3.1. Article Analysis

This literature review examines data compiled in tabular form from documented articles related to mathematical creative thinking skills and problem-based learning models. A total of 8 articles were chosen through the implementation of specific inclusion and exclusion criteria.

No	Researchers and Years	Title	Research result
i	Anni Hartini Marito Sitanggang. (2023)	APPLICATION OF A PROBLEM-BASED LEARNING MODEL TO IMPROVE STUDENTS' MATHEMATICAL CREATIVE THINKING ABILITY ON THE SUBJECT OF ONE-VARIABLE LINEAR EQUATIONS AND INEQUALITIES IN CLASS VII OF SMP NEGERI 1 SIMANINDO FY 2021/2022	In the subject of linear equations and inequalities of one variable at SMP Negeri 1 Simanindo, mathematical creative thinking skills can be increased through problem-based learning after implementing learning cycles 1 and 2.
ii	Ernita, Scolastika Mariani, et. al. (2024)	META ANALYSIS: UTILIZING PROBLEM-BASED LEARNING FOR ENHANCING CREATIVE MATHEMATICAL THINKING ABILITIES	From the results of the t-test calculations, problem-based learning improves students' mathematical creative thinking skills.
iii	Anik Handayani, Henny Dewi Koeswanti. (2021)	Meta-Analysis Model Pembelajaran Problem Based Learning (PBL) Untuk Meningkatkan Kemampuan Berpikir Kreatif	For the posttest, creative thinking skills increased compared to the pretest.

iv	Zulkarnaen, Suhirman, et. al. (2022)	The Effect of Problem Based Learning Model on Students' Creative Thinking Ability	Based on the research results, problem-based learning models have a greater impact on improving creative thinking skills than conventional learning.
v	Christina Ngadha, et. al. (2024)	Penerapan Model Problem Based Learning dalam Meningkatkan Kemampuan Berpikir Kreatif Matematika Siswa	From the results of the meta-analysis conducted, it can be concluded that problem-based learning can be applied to improve mathematical creative thinking skills.
vi	Risnawati, Zubaidah Amir, et. al. (2022)	The Effectiveness of Problem Based Learning (PBL) in Increasing Student Creative Thinking and Self-efficacy.	Problem-based learning can improve learning outcomes in these subjects and can form creative thinking skills and self-efficacy in Pekanbaru State Junior High Schools, Riau Province compared to conventional learning models.
vii	Rahma Lutfiya Khoirun Nisa, Mohammad Waluyo. (2024)	The Effectiveness of Project-Based Learning and Problem-Based Learning Models on Students' Mathematical Creative Thinking Abilities Viewed from Learning Motivation	From the test results using ANOVA, problem-based learning can improve mathematical creative thinking skills.
viii	Yanty Maria Rosmauli Marbun. (2023)	IMPROVING STUDENTS' MATHEMATICAL CREATIVE THINKING ABILITY AND MOTIVATION THROUGH PROBLEM-BASED	The increase in students' mathematical creative thinking abilities in learning using problem-based learning is higher than using conventional

	LEARNING MODEL	learning.
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Table 3. Review results

3.2 Discussion of Analysis Results

RQ 1: In what ways can implementing problem-based learning enhance students' creative thinking skills in mathematic?

Problem-Based Learning is instrumental in enhancing students' mathematical creative thinking abilities by actively engaging them in the problem-solving process. This approach allows students to identify issues, organize relevant information, and develop innovative solutions. Its application has resulted in significant advancements in various aspects of creative thinking, such as fluency, flexibility, originality, and elaboration.

The results revealed a notable improvement in students' average post-test scores compared to their pre-test scores, particularly in the domains of fluency and originality. During the learning process, students demonstrated an ability to generate more alternative solutions and propose unique ideas that had not been considered before. The effectiveness of problem-based learning was evident in the increase in student learning achievement, which progressed from a very low level to a good category, as highlighted in the research findings.

RQ 2: Do students who engage in problem-based learning demonstrate different levels of mathematical creative thinking compared to those who participate in conventional learning methods?

Significant differences were identified in the mathematical creative thinking abilities of students participating in problem-based learning versus those in traditional learning environments. The experimental group, which employed problem-based learning, achieved a higher average post-test score compared to the control group following conventional methods. Analysis of the data indicates that the average N-gain for the problem-based learning group is categorized as high, while the N-gain for the conventional group is classified as low.

This is due to the problem-based learning approach that facilitates students to be actively involved in learning through interaction with peers, analysis of real problems, and exploration of various problem-solving strategies. In contrast, conventional learning tends to focus on direct

teaching without providing enough space for students to think creatively. This difference further reinforces the idea that problem-based learning is more effective in enhancing students' creative thinking skills.

RQ 3: How effectively can problem-based learning enhance students' motivation to learn mathematic?

Problem-based learning has proven effective in significantly enhancing students' motivation to learn. Data indicates that students in the experimental group (problem-based learning) achieved higher average motivation scores compared to those in the control group. This approach fosters an interactive learning environment closely connected to students' everyday experiences, encouraging a sense of responsibility in completing tasks. As a result, students show increased engagement and enthusiasm for learning. Observations highlight that students become more active in asking questions, participating in discussions, and collaborating with peers—key factors that contribute to their heightened motivation.

4. Conclusion

RQ 1: In what ways can implementing problem-based learning enhance students' creative thinking skills in mathematic?

Problem-based learning plays a crucial role in improving students' mathematical creative thinking skills. This approach enables students to actively engage in problem identification, information analysis, and the development of innovative solutions. Notable progress is observed in various aspects of creative thinking, including fluency, flexibility, originality, and elaboration. Through this method, students become better equipped to apply creative thinking in solving mathematical challenges.

RQ 2: Do students who engage in problem-based learning demonstrate different levels of mathematical creative thinking compared to those who participate in conventional learning methods?

A significant difference exists in mathematical creative thinking abilities between students who learn through problem-based learning and those who use conventional methods. Students in the problem-based learning group performed better on the creative thinking ability

test compared to those in the conventional learning group. This approach enables students to explore their ideas more freely and apply various strategies in solving mathematical problems.

RQ 3: How effectively can problem-based learning enhance students' motivation to learn mathematic?

Problem-based learning has a significant effect on boosting students' learning motivation. Students in the problem-based learning group demonstrated higher motivations levels compared to those in the conventional learning group. The interactive, real-life-relevant, and collaboration-based learning environment motivates students to be more active and participate in learning. This supports the development of not only academic skills but also positive attitudes towards mathematics learning.

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