EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 10 Issue. 1, July 2025, pp 450-459
http://ejournal.uki.ac.id/index.php/edumatsains

The Effectiveness of the Problem-Based Learning Model on Students' Mathematical Creative Thinking Ability

Lois Oinike Tambunan[1*], Amin Fauzi[2] , Mulyono[3]
[1] Pendidikan Matematika Universitas HKBP Nommensen Pematangsiantar
[2,3] Pendidikan Matematika Universitas Negeri Medan
e-mail: **loistamb@gmail.com**

Article Info
Article history:
Received : April 24th 2025
Revised : July 26th 2025
Accepted : July 31st 2025
Available online : July 31st 2025

https://doi.org/10.33541/edumatsains.v10i1.6852

Abstract
This study aims to evaluate the effectiveness of the Problem-Based Learning (PBL) approach in enhancing the mathematical creative thinking skills of Grade XI students at SMA Negeri 1 Siantar, specifically on the topic of circles. The research design used in this study is the One-Shot Case Study Design. The population consists of all Grade XI students at SMA Negeri 1 Siantar, with the sample being class XI-2, totaling 36 students, selected using Cluster Random Sampling. Data collection was conducted using a test that had been previously validated. The descriptive analysis results showed an average test score of 87.75. Data analysis was performed using a t-test, which resulted in a significance value of 0.00 < 0.05 and a tcalculated value of 9.922 > ttable value of 2.03. Based on these findings, it can be concluded that the Problem-Based Learning model has a positive and significant effect on students' mathematical creative thinking ability in the topic of circles.

Keywords: Effectiveness, Problem Based Learning, Creative Thinking Ability.

1. Introduction

Education is one of the benchmarks for assessing the life of each individual, where every person can be developed through quality education. The Indonesian nation places great importance on education in order to create a generation capable of competing in the advancement of science and technology. This can be seen from the various efforts made by the government to improve the quality of education, including curriculum enhancement, improvement of methods, strategies, and learning models used, as well as the provision of educational facilities and (Natsir & Taufik, 2020). Education plays a vital role in raising a nation's standard of living. Fundamentally, it serves as a means to enhance the quality of human resource. The role of education is very significant in creating a knowledgeable, inclusive, and democratic society. Therefore, reforms in the field of education require improvements in the learning process to achieve effective and efficient outcomes. This approach emphasizes that education is not only about the results achieved, but also focuses

on how the learning process itself is carried out, requiring careful planning and implementation to achieve more optimal results (Satriani, S., & Fahmia, 2019). Thus, education is essential for every individual in facing the development of science and technology. Mathematics is a field of study that serves as a tool for communication, thinking, and solving practical problems. It encompasses elements of intuition and logic, construction and analysis, personal and general aspects, and includes areas such as algebra, arithmetic, analysis, and geometry (Subarianto et al., 2019).

Mathematics is a highly essential discipline in life, as it is a fundamental science used in various other fields to solve contextual problems (Ulva et al., 2020) In the field of education, especially in Indonesia, mathematics is one of the compulsory subjects that has been taught from elementary school through to higher education. Therefore, mastering mathematics is considered essential.

In learning mathematics, students are expected to possess five fundamental skills in order to master mathematics effectively. These include the ability to understand mathematical concepts, mathematical reasoning, problem-solving, mathematical representation, and an appreciation of the usefulness of mathematics (Ulva et al., 2020). These five foundational skills in mathematics must be considered to achieve success in learning the subject. One of the basic skills that currently deserves special attention in mathematics education is the ability to understand mathematical concepts.

The significance of conceptual understanding is emphasized in the goals of mathematics education set by the Ministry of National Education, which include grasping mathematical concepts, describing the connections among them, and applying concepts or algorithms with flexibility, accuracy, efficiency, and precision in solving problems (Minister of National Education Regulation No. 22 of 2006). A solid understanding of mathematical concepts is crucial in mathematics learning. Therefore, in order to grasp new concepts in mathematics, students must first understand the concepts from the previous material.

Based on the results of the international study conducted by PISA (Programme for International Student Assessment), Indonesia ranked 68th out of 81 countries in 2022. The 2022 PISA study showed that the average mathematics score of Indonesian students was 379, compared to the OECD (Organisation for Economic Co-operation and Development) average of 487. In terms of percentage, only about 24% of Indonesian students achieved at least the minimum level of mathematical competency. The presence of high-level questions was a major factor contributing to Indonesia's low PISA results. PISA questions are classified into levels 1 to 6 and are contextual in nature, based on real-life situations. Indonesian students were only able to complete level 1 and level 2 questions, which are considered routine problems (OECD, 2023). This indicates that Indonesia still struggles in solving mathematical problems. From these PISA findings, it can be concluded that Indonesian students' conceptual understanding of mathematics remains relatively low, even though they are guided and taught by teachers at school.

During the observation, the researcher identified three indicators to be used in measuring students' mathematical creative thinking abilities: elaboration on questions number 1 and 2, and both fluency and flexibility on question number 2. Based on the initial ability test given to 36 students, the data showed that 80.56% of students were unable to meet the flexibility indicator, 47.22% were unable to meet the elaboration indicator, and 72.23% were unable to meet the fluency indicator. Based on

these results and the corresponding indicators, the researcher concluded that students' mathematical creative thinking ability is still low. This low level of creative mathematical thinking makes it more difficult to achieve the goals of national education and hinders individuals from adapting to the rapid developments in the modern era.

This issue may be caused by several factors, one of which is the learning model used by teachers during the learning process. Teachers need to implement specific strategies to enhance students' creative thinking skills by using various learning models (Ni'mah & Sukartono, 2022). A learning model serves as a structured framework that defines systematic methods for designing and organizing learning activities to attain targeted educational goals (Anggraini et al., 2020). According to (Purbiyanti, A., & Mustofa, 2023), a learning model is a sequence of activities that provides a framework for the implementation of teaching and learning activities, aiming to make the learning process more enjoyable and to help students achieve their learning goals. Therefore, it can be concluded that a learning model serves as a guide for educators in designing and conducting teaching and learning activities to achieve specific educational goals.

Creative thinking ability refers to an individual's capacity to generate and develop original ideas. In the context of education, this is often referred to as student creativity (Rachmantika et al., 2022). Creative thinking involves approaches to modifying or refining problems, being open to new ideas, and viewing situations from different perspectives. According to (Asmara et al., 2017), this ability can be demonstrated through divergent thinking, which is not solely focused on right or wrong answers. Creativity does not emerge spontaneously; instead, it requires a continuous process of practice and training. Therefore, teachers play a crucial role in fostering students' creativity. They can do this by applying teaching methods that encourage creative thinking and presenting challenges that stimulate students' cognitive abilities (Meika & Sujana, 2017).

This study examines students' mathematical creative thinking skills based on three main indicators: fluency, flexibility, and novelty. Fluency refers to the ability to generate various relevant ideas, flexibility reflects the use of diverse strategies in problem solving, and novelty indicates the production of unique or original solutions. These indicators were selected to comprehensively represent the essential aspects of mathematical creative thinking.

In selecting a learning model, several considerations are necessary, including: alignment with the intended learning objectives, the nature of the subject matter or learning materials, the characteristics and needs of the learners or students, as well as other non-technical factors. Today, there are numerous strategies and learning models designed to enhance the quality of learning, one of which is the Problem-Based Learning (PBL) model. Problem-Based Learning is a sequence of teaching and learning activities that focuses on solving real-world problems encountered in everyday life (Handayani & Koeswanti, 2021). According to (Suparman, 2015) Problem-Based Learning is an approach in which students work together to solve problems and engage in reflection on their learning experiences. Furthermore, the Problem-Based Learning model applies a pattern of presenting problems or cases for students to solve, confronting them with real-life issues. The goal is to provide students with the opportunity to be actively involved in constructing their own knowledge through the process of problem-solving (Novianti; Roesdiana, 2022).

2. Methods

The type of research used in this study is Pre-Experimental Design with a quantitative approach. Pre-Experimental Designs involve research that includes only one group or class, without the presence of a control group (Sugiyono, 2021). This study aims to assess the effectiveness of the Problem-Based Learning (PBL) model in enhancing Grade XI students' understanding of mathematical concepts related to the topic of circles at SMA Negeri 1 Siantar. In this study, the design used is a One-Shot Case Study. The reason for choosing this design is that the results of the treatment can be determined more accurately by comparing the condition after the treatment to the situation prior to it. The research design can be illustrated as follows:

Table 1.

One Shot Case Study Research Design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2

According to (Sugiyono, 2021) probability sampling is a technique that gives each element (member) of the population an equal chance of being selected as part of the sample. The specific technique that will be applied to the population data of the Grade XI students at SMA Negeri 1 Siantar in this research is cluster random sampling. Cluster Random Sampling is a sampling technique used to determine a sample when the object or source of data is very broad, and the sampling is done randomly. The sample for this study consists of Grade XI-2 students at SMA Negeri 1 Siantar, totaling 36 students, who were selected to be part of the sample for the research. It is hoped that the results of this study will reflect the entire population.

This study utilized test instruments, including 2 pre-test questions and 4 post-test questions. The pre-test was administered to evaluate students' mathematical creative thinking skills prior to the implementation of the treatment. The post-test was conducted at the end of the study to evaluate students' mathematical creative thinking skills following the application of the treatment. Both the pre-test and post-test were developed based on indicators related to the variable under investigation, namely mathematical creative thinking ability.

Techniques and Instruments of Data Collection

The sampling method used in this study applies a probability sampling approach, specifically cluster sampling (also known as area sampling). According to (Sugiyono, 2018), this method provides equal opportunities for all members of the population to be selected as part of the sample. Cluster sampling was chosen because the research population is grouped into specific clusters. The selection of samples is based on the assumption that each cluster consists of students with relatively similar characteristics, allowing representatives from each cluster to be selected for

analysis. The data collected in this study pertains to the mathematical creative thinking skills of 11th-grade high school students. The data collection techniques used were tests and observation.

Data Analysis Technique

Data analysis encompassed both the learning process and its outcomes. The process analysis focused on the implementation of the two instructional models used in the study, while the outcome analysis examined test results to determine the effectiveness of the Problem-Based Learning model on students' creative thinking abilities. To compare mean scores, an Independent Sample T-Test was employed using post-test data collected after the intervention. Hypothesis testing followed specific criteria: the null hypothesis (H0) was accepted if the p-value exceeded 0.05, while the alternative hypothesis (Ha) was accepted if the p-value was below 0.05. After evaluating the impact of each model on students' creative thinking skills, an N-Gain test was applied to measure the degree of effectiveness in the experimental group. The Effect Size results are summarized in the table below.

Table 2.

Effect Size Test Calculations Result

Effect Test Size	Category
0.099	Low

The result of the effect size calculation is 0.099, which falls into the small category (d = 0.099). This indicates that the use of the Problem Based Learning method is effective in improving students' learning outcomes.

3. Result and Discussion

The data description and analysis in this study focus on presenting the quantitative results obtained from test instruments administered to a single class serving as the research sample. The study implemented the Problem-Based Learning (PBL) model to assess its effectiveness in improving students' mathematical conceptual understanding of the topic of circles. The data description includes a summary of statistical measures such as data range, maximum and minimum values, mean, and other relevant indicators.

Following the application of the PBL model, students completed a mathematical creative thinking test composed of four essay questions, which had previously been piloted with class XII-6. The data used in this study were collected from class XI students to evaluate whether PBL effectively enhanced their creative mathematical thinking in the context of circle-related topics. The implementation of the Problem-Based Learning (PBL) model in this study followed several structured steps in the classroom. Students were first presented with a contextual problem to explore collaboratively, followed by group discussions to analyze the problem, formulate hypotheses, and propose solutions. Finally, each group presented their findings, and the teacher facilitated a reflection session to deepen understanding and connect the solutions to relevant

mathematical concepts.

The primary research instrument was a conceptual understanding test consisting of four essay questions. This instrument underwent thorough item analysis, including assessments of validity, reliability, item difficulty, and discrimination, along with revisions based on feedback from supervising lecturers and mathematics teachers. After the trial phase, validated test items were used to collect data on students' conceptual understanding. Class XI-2, selected as the experimental group, then received instruction using the PBL model focused on the topic of circles.

Before conducting the research, a test instrument trial was carried out. This was done to determine whether the test items met research standards. In this study, the trial of the mathematical creative thinking ability test was conducted in class XII-6. The test items were then analyzed using validity, reliability, difficulty level, and discrimination index tests. Based on the trial conducted with a sample size of N = 36 and a significance level of 5%, the rtable value was 0.3291. From the results of the validity test, it was found that all four items in the mathematical creative thinking ability test were valid.

For decision-making criteria in Cronbach's Alpha technique, if the value of rcalculated > 0.70, the test is considered reliable. The reliability test result showed that the Cronbach's Alpha value for the mathematical creative thinking ability test was 0.765, which falls into the category of high reliability. Thus, the test is considered reliable and suitable for use in the study. After confirming that the test met research standards, the researcher proceeded with the study by first providing treatment to the sample using the Problem-Based Learning (PBL) model. After the learning process using the model was completed, a post-test on mathematical creative thinking ability of the Circle topic was administered to determine the students' understanding after the treatment.

After obtaining the concept understanding scores, the data were then analyzed. The calculated mean score was 87.75. A normality test was performed as a prerequisite before hypothesis testing. The normality test used the Kolmogorov-Smirnov method in SPSS 22.0 and Excel, with the criterion Sig. > 0.05. The normality test result for the mathematical creative thinking ability test data was 0.200 > 0.05, indicating that the data were normally distributed.

Subsequently, the researcher conducted hypothesis testing using a t-test to determine the effectiveness of variable X on variable Y, resulting in a significance value of 0.000 < 0.05. Given n = 36, then df = n – k = 36 – 1 = 35. With df = 35 and α = 5%, the ttable value was 2.03. Since tcalculated > ttable = 9.922 > 2.03, it can be concluded that the Problem-Based Learning model had a significant effect on students' mathematical creative thinking ability.

Table 3.
T-test Result

One Sample Test

	Test Value =78					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Y	9.922	35	.000	9.750	7.76	11.74

To calculate the improvement in the average scores between the pretest and posttest, the normalized mean gain formula is used, which is the ratio of the actual mean gain to the maximum mean gain. The actual mean gain is the difference between the average scores of posttest 1 and posttest 2. This normalized gain formula is also referred to as the g factor, or Hake factor (Wiyanto, 2008).

$$g = \frac{\bar{S}_{Posttest} - \bar{S}_{Pretest}}{100\% - \bar{S}_{Pretest}}$$

Description : g = g factor (Hake factor) or normalized score gain value

Table 4.
N-Gain

No	Criteria	Interval Value Description
1	High	$g \geq 0.7$ or expressed as a percentage $g \geq 70$
2	Moderate	$0.3 \leq g < 0.7$ or expressed as a percentage $30 \leq g < 70$
3	Low	$g < 0.3$ or expressed as a percentage $g < 30$

The results of the gain normality test for the experimental group show an average increase of 0.71, placing the N-Gain in the high category. This suggests that the Problem-Based Learning (PBL) model is effective in enhancing students' creative thinking skills. The output from the Independent Sample T-Test, presented in Table 3, indicates a two-tailed significance value of 0.000, which is less than 0.05. Therefore, H0 is rejected and Ha is accepted, signifying a significant difference in

the effectiveness of the PBL model in improving students' mathematical creative thinking abilities in class XI at SMA Negeri 1 Siantar.

The success of the PBL model in enhancing students' mathematical creative thinking abilities is influenced by the learning activities that guide students to solve problems. Habitual use of this model can effectively improve students' mathematical creative thinking skills. This is in line with Hung's statement (in Astuti, 2010) that requiring students to solve problems as the primary format in instruction can enhance their ability and skills in applying knowledge, solving problems, and practicing higher-order thinking. This result reinforces research conducted by (Yusri, 2018) which showed that the implementation of the PBL model can improve students' problem-solving abilities. Similarly, research by (Ruchaedi & Baehaki, 2016) found that the PBL model can enhance the ability to use heuristic strategies for solving mathematical problems more effectively.

4. Conclusion

Based on the data analysis and discussion, it can be concluded that the Problem-Based Learning model has a positive and significant impact on enhancing students' mathematical creative thinking skills in the topic of circles for Grade XI at SMA Negeri 1 Siantar. This is evidenced by the students' mean post-test score of 87.75 after applying the PBL model. The effectiveness is further confirmed by hypothesis testing using a t-test, where tcalculated (9.922) > ttable (2.03), leading to acceptance of the alternative hypothesis. Problem-Based Learning approach, the learning process becomes more enjoyable. Students can recognize the relationship between the problem and its solution format and are able to relate it to their everyday lives. The Problem-Based Learning model is effective in positively influencing students' mathematical creative thinking ability in the topic of Circles. Therefore, in future studies it is hoped that this problem based learning model can be applied to other mathematics topics.

5. References

Anggraini, F., Lestari, H. M. Z. H. M. M. A., & Hafniati, T. (2020). Ragam Model Pembelajaran. In Cv.Eureka Media Aksara (Vol. 7, Issue 2).

Asmara, R., Susantini, E., & Rahayu, Y. S. (2017). Pengembangan Perangkat Pembelajaran Biologi Berorientasi Pendekatan Tasc (Thinking Actively in Social Conteks) Untuk Melatihkan Keterampilan Berpikir Kreatif Siswa. JPPS (Jurnal Penelitian Pendidikan Sains), 5(1), 855. https://doi.org/10.26740/jpps.v5n1.p855-891

Dwi Afnan Puji Astuti, Slameto, dan E. W. S. (2010). PENGARUH MODEL PEMBELAJARAN PROBLEM BASED LEARNING TERHADAP KEMAMPUAN PEMECAHAN MASALAHMATEMATIKA SISWA SEKOLAH DASAR. Trends in Cognitive Sciences, 14(2), 88–100. http://landing.adobe.com/en/sea/products/acrobat/69210-mayprospects.html?trackingid=KTKAA

Handayani, A., & Koeswanti, H. D. (2021). Meta-Analisis Model Pembelajaran Problem Based Learning (PBL) Untuk Meningkatkan Kemampuan Berpikir Kreatif. Jurnal Basicedu, 5(3), 1349–1355. https://doi.org/10.31004/basicedu.v5i3.924

Meika, I., & Sujana, A. (2017). Kemampuan Berpikir Kreatif Dan Pemecahan Masalah Matematis Siswa Sma. Jurnal Penelitian Dan Pembelajaran Matematika, 10(2), 8–13. https://doi.org/10.30870/jppm.v10i2.2025

Natsir, I., & Taufik, A. R. (2020). Penerapan Model Pembelajaran Group Investigation Dalam Meningkatkan Hasil Belajar Matematika Siswa. JUPITEK: Jurnal Pendidikan Matematika, 3(1), 33–38. https://doi.org/10.30598/jupitekvol3iss1pp33-38

Ni'mah, A., & Sukartono. (2022). Upaya Guru dalam Meningkatkan Kreativitas Berpikir Peserta Didik di Sekolah Dasar. Jurnal Penelitian Dan Pengembangan Pendidikan, 6(2), 173–179. https://doi.org/10.23887/jppp.v6i2.48157

Novianti; Roesdiana, L. (2022). ANALISIS KEMAMPUAN PEMECAHAN MASALAH MATEMATIS SISWA SMA DALAM MENYELESAIKAN SOAL SISTEM PERSAMAAN LINEAR TIGA VARIABEL. EduMatSains.

OECD. (2023). PISA 2022 Result (Colume I): The State of Learning and Equity in Education. OECD Publishing.

Prof.Dr.Sugiyono. (2021). Metode_Penelitian_Pendidikan_Sugiyono_20.pdf (pp. 47–281)

Purbiyanti, A., & Mustofa, A. (2023). Penggunaan model pembelajaran learning by games dalam pembelajaran ips materi kegiatan ekonomi pada siswa kelas v di sd negeri 4 sempu tahun pelajaran. 1, 2022–2023.

Rachmantika, A. R., Waluya, S. B., & Isnarto, I. (2022). Kemampuan Berpikir Kreatif Matematis pada Pembelajaran Project Based Learning dengan Setting Daring. Edukatif : Jurnal Ilmu Pendidikan, 4(2), 2609–2615. https://doi.org/10.31004/edukatif.v4i2.1100

Ruchaedi, D., & Baehaki, I. (2016). Pengaruh Problem Based Learning (Pbl) Terhadap Kemampuan Heuristik Pemecahan Masalah Dan Sikap Matematis Siswa Sekolah Dasar. Jurnal Cakrawala Pendas, 2(2). https://doi.org/10.31949/jcp.v2i2.331

Satriani, S., & Fahmia, S. (2019). Efektivitas Pembelajaran Matematika Melalui Penerapan Model Kooperatif Tipe Goup Investigation (GI) Pada Siswa Keìlas X SMA Negeri 3 Sidrap. Nabla Dewantara : Jurnal Pendidikan Matematika, 4(1), 35–45.

Subarianto, Ikhsan, M., & Munzir, S. (2019). Meningkatkan kemampuan representasi dan pemecahan masalah matematis siswa melalui pendekatan problem posing dalam pembelajaran matematika. Jurnal Peluang, 7(1), 127.

Sugiyono. (2018). Metode Penelitian Pendidikan. Alfabeta.

Suparman. (2015). Peningkatan Kemampuan Berpikir Kreatif Siswa Melalui Penerapan Model Problem Based Learning. Jurnal Bioedukasi, 8(2), 101–106. https://doi.org/10.24114/jtp.v8i2.3329

Ulva, E., Maimunah, M., & Murni, A. (2020). Pengaruh Model Problem Based Learning Terhadap Kemampuan Pemecahan Masalah Matematis Siswa Kelas VII SMPN Se-Kabupaten Kuantan Singingi Pada Materi Aritmetika Sosial. Jurnal Cendekia : Jurnal Pendidikan Matematika, 4(2), 1230–1238. https://doi.org/10.31004/cendekia.v4i2.356

Wiyanto. (2008). Pengembangan Kemampuan Merancang dan Melaksanakan Kegiatan Laboratorium Fisika Berbasis Inkuiri Bagi Mahasiswa Calon Guru. PPs UPI Bandung.

Yusri, A. Y. (2018). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Pemecahan Masalah Matematika Siswa Kelas Vii Di Smp Negeri Pangkajene. Mosharafa: Jurnal Pendidikan Matematika, 7(1), 51–62. https://doi.org/10.31980/mosharafa.v7i1.341