

The Effect of the Problem-Based Learning Model on Students' Critical Thinking Skills

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Abstrak

Penelitian ini bertujuan untuk mengkaji pengaruh model pembelajaran *Problem Based Learning* (PBL) terhadap kemampuan berpikir kritis siswa sekolah menengah atas. Kemampuan berpikir kritis merupakan salah satu keterampilan abad ke-21 yang esensial dalam membekali siswa menghadapi kompleksitas permasalahan kehidupan nyata. Penelitian ini menggunakan metode kuasi eksperimen dengan desain *nonequivalent control group design*, melibatkan dua kelas XI di SMA Negeri 1 Sedayu sebagai sampel, yaitu kelas eksperimen yang mendapatkan perlakuan model PBL dan kelas kontrol yang menggunakan pembelajaran konvensional. Data dikumpulkan melalui tes esai berpikir kritis berdasarkan indikator Ennis serta observasi selama proses pembelajaran. Hasil analisis statistik menggunakan uji *paired sample t-test* dan *independent sample t-test* menunjukkan bahwa terdapat peningkatan signifikan kemampuan berpikir kritis siswa setelah penerapan model PBL. Selain itu, terdapat perbedaan signifikan antara hasil posttest kelas eksperimen dan kelas kontrol, di mana kelas eksperimen menunjukkan rata-rata nilai yang lebih tinggi. Dengan demikian, model pembelajaran *Problem Based Learning* terbukti efektif dalam meningkatkan kemampuan berpikir kritis siswa. Penelitian ini merekomendasikan penerapan PBL secara lebih luas sebagai strategi pembelajaran untuk mengembangkan keterampilan berpikir tingkat tinggi di sekolah.

Kata Kunci: *Problem Based Learning*, Berpikir Kritis, Pendidikan Matematika.

Abstract

This study aims to examine the effect of the Problem Based Learning (PBL) model on students' critical thinking skills in senior high school. Critical thinking is a crucial 21st-century skill that equips students to address complex real-life problems. The research employed a quasi-experimental method with a nonequivalent control group design, involving two Grade XI classes at SMA Negeri 1 Sedayu. One class was treated with the PBL model (experimental group), while the other received conventional instruction (control group). Data were collected through essay tests based on Ennis's critical thinking indicators and classroom observations. Statistical analysis using paired sample t-test and independent sample t-test revealed a significant improvement in students' critical thinking skills after the implementation of PBL. Moreover, the posttest scores of the experimental group were significantly higher than those of the control group. These findings indicate that the PBL model is effective in enhancing students' critical thinking abilities. This research suggests the broader implementation of PBL as an instructional strategy to foster higher-order thinking skills in schools.

Keyword: *Problem Based Learning, Critical Thinking, Mathematics Education.*

INTRODUCTION

Education plays a key role as the main foundation in creating a generation that is critical, innovative, and ready to face global challenges (Thana & Hanipah, 2023). In addition, education is the main element that supports the progress of a nation. The level of progress of a nation can be seen from the quality of its education (Mustakim, 2011). Quality education is able to produce the next generation who are skilled and knowledgeable (Sanga & Wangdra, 2023). In accordance with the purpose of national education, which is to educate the life of the nation, as mandated in the Preamble to the 1945 Constitution paragraph 4, which is to educate the life of the nation and contribute to realizing world order based on independence, lasting peace, and social justice. Quality education not only plays a role in educating the nation's life, but also opens up opportunities to develop various scientific fields, such as mathematics, which is one of the important disciplines in shaping students' critical and logical thinking skills (Rasyad, 1999). In the 21st century era, critical



thinking skills are the main competencies that students must possess in order to be able to face the complexity of problems in real life. This ability includes the ability to analyze information, evaluate arguments, draw logical conclusions, and solve problems systematically (Agustina, 2019).

Critical thinking skills are important skills in analyzing, evaluating, and filtering information objectively before making decisions or drawing conclusions (Fatoni, 2023). This ability includes the process of identifying problems, evaluating arguments, detecting biases, and considering various viewpoints logically and deeply (Haeruman et al., 2017). Ennis (2011) stated that critical thinking indicators include focus on problems, logical reasoning, the ability to make inferences, understanding the context, clarity in the delivery of ideas, and the ability to evaluate thoroughly.

In the context of education, critical thinking skills are essential to form students who are independent, reflective, and able to think rationally (Manurung et al, 2023). Especially in mathematics learning, this ability encourages students to not only memorize formulas, but also understand concepts thoroughly and apply them in solving contextual problems (Hutagaol, 2013). Therefore, the development of critical thinking skills is one of the main goals in the implementation of innovative learning models (Tibahary & Muliana, 2018). However, the learning process in various educational units still tends to be dominated by a teacher-centered approach, which does not provide space for students to actively develop and hone critical thinking skills optimally.

Based on the results of tests conducted on grade XI students at SMA Negeri 1 Sedayu on December 6, 2024, especially on 36 students in grades XI-3 and XI-4, it was found that the level of students' critical thinking ability was in the very low category. The results of the preliminary study of the students' critical thinking ability test can be seen in table 1. next:

Table 1. Students' Critical Thinking Ability

Category	Percentage	
	XI-3	XI-4
Very high	5,56%	0,00%
Tall	5,56%	13,89%
Keep	5,56%	2,78%
Low	36,11%	33,33%
Very low	38,89%	41,67%

Based on the test results listed in table 1 above, it shows that students' critical thinking skills are still relatively low to very low. Students often have difficulty developing logical arguments, analyzing problems in depth, and exploring creative solution strategies. This is exacerbated by learning methods that are still conventional and tend to be teacher-centered, making students passive and less actively involved in learning. Critical thinking skills are very important in learning mathematics because they can help students analyze problems, find creative solutions, and understand concepts in depth (Sulistiani & Masrukan, 2017). Therefore, an appropriate learning model is needed, one of which is the *Problem Based Learning* (PBL) learning model, which can train critical thinking skills through contextual problem solving by creating relevant and interactive learning experiences (Fakhriyah, 2014).

The Problem Based Learning (PBL) learning model is a learning approach that focuses on solving real problems as the main way to develop students' learning skills (Wardani, 2023). According to Fonna and Nufus (2024), in this model students are faced with situations or challenges relevant to daily life, which encourages them to think critically, collaborate, and apply the knowledge they have learned. Furthermore, Hidayati (2018) explained that PBL not only improves conceptual understanding, but also trains high-level thinking skills that are indispensable in 21st century learning.

Based on the above background, this study is focused on examining the effect of the application of the PBL learning model on the critical thinking ability of high school students. In particular, the study aimed to find out whether there was an improvement in critical thinking skills after learning with the PBL model, as well as whether there was a significant difference in critical thinking skills between students who learned using the PBL model and students who followed conventional learning. The results of the research are expected to be the basis for the development of more effective learning strategies in building students' critical thinking skills in schools.

METHOD

This research is included in the type of quasi-experiment using a nonequivalent control group design. The goal is to find out the extent of the influence of the Problem Based Learning (PBL) learning model on students' critical thinking skills, as explained by Sugiyono (2013). The research was carried out at SMA Negeri 1 Sedayu in the even semester of the 2024/2025 school year by involving two class XI as samples, namely class XI-3 as an experimental group using the PBL model, and class XI-4 as a control group with conventional learning, each totaling 36 students. PBL treatment is given in four meetings on geometry transformation material (translation and reflection) with five learning stages, namely problem orientation, data collection, data analysis, solution preparation, and presentation. The main instrument is a critical thinking essay test which is compiled based on six indicators from Ennis, namely: *Focus*, *Reason*, *Inference*, *Situation*, *Clarity*, and *Overview*. The validity of the question item was tested by *product moment* correlation using SPSS Software for Windows and all the value of the correlation coefficient from question item number 1 to 5 was positive or with. Thus, it can be concluded that all the questions in the critical thinking ability test have been proven valid. $r_{xy} > r_{tabel} = 0,36$ In addition, the reliability of the questions was tested with the help of SPSS Software for Windows, obtained a *Cronbach's Alpha value* $> 0,8$ which means that the test questions are in the high reliability category. Data was collected through pretests and posttests given before and after treatment. Data analysis was carried out through a normality test (Shapiro-Wilk), a homogeneity test (Levene's Test), a *paired sample t-test* to see an improvement in the group, and an *independent sample t-test* to compare the results between the experimental and control groups. This test was carried out with a level of significance 5% ($\alpha = 0,05$).

RESULTS AND DISCUSSION

The results presented are experiments that have been carried out by researchers, namely the application of the Problem Based Learning (PBL) learning model to improve students' critical thinking skills. The main instrument used in this study is an essay test which is compiled to measure students' critical thinking skills as a whole. This test is designed based on six critical thinking indicators developed by Ennis, namely *Focus* (focus on the problem), *Reason* (logical reason), *Inference* (drawing conclusions), *Situation* (understanding context), *Clarity* (clarity in the delivery of ideas), and *Overview* (overall evaluation). The results of the research were obtained with the help of pretest and posttest questions on the ability to think critically on geometry transformation materials (translation and reflection). The pretest was given in the control class on January 3, 2025 and in the experimental class on January 6, 2025. Meanwhile, the posttest was given in the control class on January 17, 2025 and in the experimental class on January 20, 2025. After the pretest and posttest questions were given to the experimental class and the control class, the researcher conducted a calculation using the help of SPSS Software for Windows to draw conclusions about the influence of the *Problem Based Learning* learning model on students' critical thinking skills.

The testing steps carried out by the researcher are as follows:

1. Prerequisite Test

The prerequisite tests used by the researcher include the normality test and the homogeneity test. This prerequisite test is carried out to find out that the pretest and posttest data used are distributed normally and homogeneously.

a. Normality Test

The normality test of a data was carried out by the researcher using the help of SPSS software for windows, namely with the *Shapiro-Wilk normality test* because the data used amounted to less than 50 respondents. The following are the results of the normality test presented in table 2.

Table 2. Normality Test Results

Data	Shapiro-Wilk		information
	Class	Significance value	
Pretest	Eksperimen	0,111	Normal Distributed
	Control	0,066	Normal Distributed

Posttest	Eksperimen	0,087	Normal Distributed
	Control	0,522	Normal Distributed

Based on the results of the normality test in table 2, it appears that the significance value in the Shapiro-Wilk test in the pretest of the control class test was 0.066 and in the experimental class was 0.111, while in the posttest value of the control class test was 0.522 and in the experimental class 0.087. Using a significance level of 0.05, it can be concluded that the distribution of test data for the pretest and posttest of the experimental class and the control class is normally distributed.

b. Homogeneity Test

The homogeneity test of a data was carried out by researchers using the help of SPSS software for windows, namely the Levene's Test homogeneity test. The following are the homogeneity test results from the posttest data in the experimental class and the control class presented in table 3.

Table 3. Homogeneity Test Results

	<i>Levene's test</i>	Df1	Df2	Itself.
Pretest	0,454	1	54	0,503
Posttest	0,010	1	54	0,919

Based on the results in table 3, the *Levene's test* score for pretest data is 0.454 with a significance value of 0.503, while the *Levene's test* score for posttest data is 0.010 with a significance value of 0.919. By using a significance level of 0.05 assuming that the data is normally distributed when the significance value, it can be concluded that the pretest and posttest have homogeneous variance. > 0,05

Based on the results of the prerequisite test above, it can be concluded that the pretest and posttest data in the experimental class and the control class were distributed nasal and homogeneous. Thus, the influence of the problem-based learning model will be analyzed using parametric statistical tests.

2. Influence Test

a. Paired Sample T-Test

In this study, the *Paired Sample T-test* was used to compare the average critical thinking ability of students before and after the application of the *Problem Based Learning learning model* in the experimental group. The following are the results of the *Paired Sample T-Test* on:

1) The influence of students' critical thinking skills using the Problem Based Learning (PBL) learning model

This test was carried out using pretest and posttest data on the critical thinking ability of students in the experimental class. The test results are presented in table 4.

Table 4. Results of Paired Sample T-Test Experimental Class

	Mean	Std. deviation	T	Df	Sig.
Pair 1					
Pretest – posttest experimental class	-43,393	24,909	-9,218	27	0,000

Based on table 4, it shows that the value of Sig. < 0,05, shows an increase in students' critical thinking skills in experimental classes before and after the implementation of Problem Based Learning.

2) The influence of students' critical thinking skills without using the Problem Based Learning (PBL) learning model

This test was carried out using pretest and posttest data on the critical thinking ability of control class students. The test results are presented in the following table 5

Table 5. Results of Paired Sample T-Test Control Class

	Mean	Std. deviation	T	Df	Sig.
Pair 2					
Pretest – posttest control class	-25,893	22,692	-6,038	27	0,000

Based on table 5, it shows that the value of Sig. < 0,05, showing an increase in students' critical thinking skills in the control class before and after the implementation of Conventional Learning.

b. Independent Sample T-Test

In this study, the independent sample T-test was used to compare the average critical thinking ability between the experimental group using the PBL learning model and the control group using the conventional learning model. The following are the results of the Independent Sample T-Test presented in table 6.

Table 6. independent Sample T-Test Result

	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	0,410	0,525	5,386	54	0,000

Based on table 6, it shows that the value of Sig. (2-tailed), $< 0,05$ it shows a significant difference in the level of critical thinking ability between students in the experimental class and in the control class. Therefore, it can be concluded that learning using the Problem Based Learning model is more effective in improving students' critical thinking skills than conventional learning.

c. Mean Difference Test

In addition to applying the *Paired Sample T-Test* and *Independent Sample T-Test* to measure effectiveness, the study also compared the average improvement between the experimental class and the control class. The average comparison was made based on pretest and posttest data on critical thinking skills. The results of the analysis of the difference in average increase between the pretest and posttest in both classes can be seen in Table 7. as follows:

Table 7. Comparison of Average Pretest and Posttest Scores

	Control Class		Experimental Classes	
	Pretest	Posttest	Pretest	Posttest
Grade Point Average	44,82	73,57	38,75	82,14
Increased	28,75		43,39	

Based on Table 7, it can be seen that the average increase in the value in the control class was 28.75, while in the experimental class it reached 43.39. These findings indicate that the *Problem Based Learning* (PBL) learning model has a greater impact on improving students' critical thinking skills compared to conventional learning.

Based on the results of the influence test that has been carried out, it can be concluded that the use of the Problem Based Learning learning model can have a significant influence on students' critical thinking skills. The difference in the average increase of the pretest and posttest in the experimental class and the control class is presented in figure 1 below:

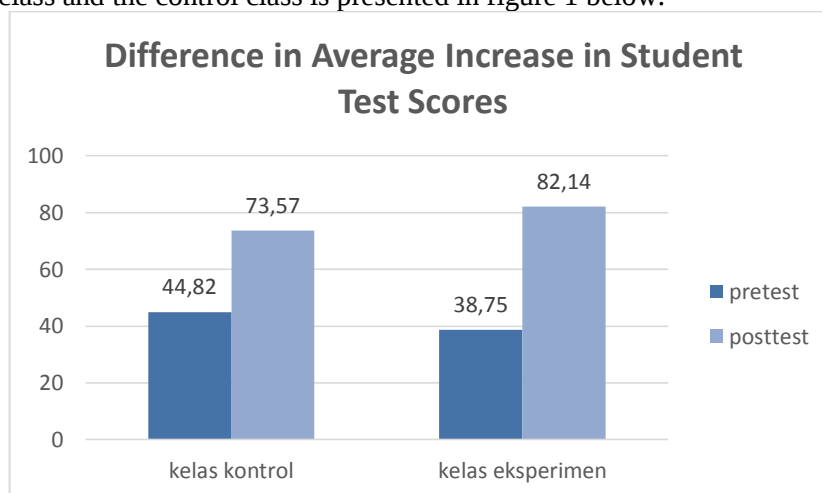


Figure 1. Difference in Average Increase in Student Test Scores

The results of this study show that the application of the Problem Based Learning (PBL) learning model has a significant influence on improving students' critical thinking skills. This finding is in line with the theory put forward in the introduction, where critical thinking skills are one of the essential skills of the 21st century that need to be developed in the learning process (Agustina, 2019; Fatton, 2023). PBL as a learning model that emphasizes real problem solving, has been proven to be able to encourage students to be actively involved in identifying problems, analyzing information, and formulating and evaluating solutions logically. This is in accordance

with the indicators of critical thinking according to Ennis which include focus, logical reasoning, inferences, understanding of context, clarity, and thorough evaluation (Ennis, 2011).

In the context of mathematics learning, critical thinking skills are very important because students are not only required to memorize formulas, but also to understand concepts and apply them in solving problems systematically (Sulistiani & Masrukan, 2017). The application of PBL in this study succeeded in creating a contextual and meaningful learning atmosphere, which triggered students to think deeper, ask critical questions, and develop arguments. This is also supported by the calculation results of the Paired Sample T-Test which showed a significant increase in the experimental class, as well as the Independent Sample T-Test which confirmed the existence of a real difference between the experimental class and the control class.

Furthermore, the increase in average student learning outcomes in the experimental class shows that problem-based learning strategies are able to improve the quality of student thinking more optimally than conventional learning that tends to be teacher-centered. This condition strengthens the opinion of Hidayati that PBL not only improves understanding of concepts, but also forms high-level thinking skills that are relevant to face the global challenges of the 21st century (Hidayati, 2018). Therefore, the results of this study reinforce the importance of developing innovative learning strategies such as PBL as one of the effective approaches in fostering students' critical thinking skills in high school.

CONCLUSION AND SUGGESTION

1. Conclusion

Based on the results of the research that has been conducted, it can be concluded that the *Problem Based Learning* (PBL) learning model has a significant influence on improving students' critical thinking skills. The application of the PBL model in experimental classrooms has been proven to improve students' ability to analyze, evaluate, and solve problems logically and systematically compared to students in control classes who use conventional learning. This is shown through a significant difference in *pretest* and *posttest* results and supporting statistical test results. PBL encourages active student engagement, increases learning motivation, and creates a more meaningful and contextual learning environment.

2. Suggestion

- a. For teachers, it is recommended to implement the *Problem Based Learning* learning model in the learning process, especially in materials that require high-level thinking skills.
- b. For schools, it is necessary to conduct training or workshops to improve teachers' competence in implementing innovative learning models such as PBL optimally and sustainably.
- c. For the next researcher, it is recommended to conduct further research with a wider scope, both in terms of the number of samples, education level, and other variables such as learning motivation or collaborative ability to gain a deeper understanding of the effectiveness of PBL.

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