



Analysis of Problem-Based Learning Model on Mathematical Critical Thinking Skills of Elementary School Students

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Abstract:

PBL is a learning model that leads to strengthening competence of problem-solving, critical reasoning, and learning about learning. The purpose of this study was to determine the significance of the effect of applying the PBL learning model on the critical thinking competence of sixth-grade elementary school students on circle material. The approach applied in this study is a quantitative approach with a pre-test and post-test critical thinking design type. Data collection techniques in this study used critical thinking tests. The participants who were included in this study were 25 students of class VI at SDN 173270, Siborong-Borong, North Sumatera. Data analysis using a one-sample t-test. Based on the calculation of the hypothesis testing is done using the t-test. The normality test results for the value of critical thinking results are $0.139 > \alpha$ (0.05) exceeding the significant value, then the variable values are normally distributed, followed by using the one-sample t-test, the t-test results on the equation of the variance section which are assumed to show the Sig value (2-tailed) $< \alpha$ ie $0.000 < 0.05$ then reject H_0 . So it can be concluded that there is a significant effect of the application of PBL on the mathematical critical thinking skills of grade VI elementary school students.

Keywords:

Elementary School, Mathematical Critical Thinking (MCT), Problem Based Learning (PBL)

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INTRODUCTION

Education is a basic need in forming a society that is able to develop a better life, especially in the development of technology and science (Benešová & Tupa, 2017; Durkheim & Collins, 2006; Ritonga et al., 2022). The challenges of the 21st era force each individual to have 4C skills, namely creativity, collaboration, critical thinking, and communication (Azaryahu et al., 2023; Stephenson, 2023). One of the fundamental 21st-century competencies that humans must possess is critical thinking skills (Bassanezi, 1994; Gravemeijer & Eerde, 2009; Serezli et al., 2023). One measure of the quality of human resources is critical thinking skills (Uribe-Enciso et al., 2017) Critical thinking is the initial stage towards reflective thinking, namely human ability in the review stage by producing arguments which are the results of conclusions from relevant evidence, as well as the use of appropriate information in solving problems at a higher stage (Bailin, 2002; Reynders et al., 2020; Syaiful et al., 2022)

The pedagogic strategies that are able to encourage critical thinking skills are strategies that (a) start with an unusual question or activity, (b) challenge students, (c) involve acquisition and practice activities or both, as well as students' procedural

knowledge, (d)) there are products or works that support real learning and can be observed and documented, (e) involve problems with various possible solutions to problem-solving, (f) allow for unexpected answers to students' thoughts in problem-solving, and (g) there is time and space for reflection or giving feedback on the ongoing learning process (Harris et al., 2022; Syaiful et al., 2022) In addition, by thinking critically, a person will possess and develop other skills such as high attention, analytical skills, and better thought processes (Changwong et al., 2018). Mathematical critical thinking skills are a process of thinking systematically to develop logical and critical thinking on mathematical problems (Syafri et al., 2020) . "Mathematical critical thinking skills can be defined as the ability to think to integrate new knowledge with existing knowledge, reasoning abilities, and apply cognitive understanding in mathematical problem-solving situations" (Widyatingtyas et al., 2015; Yuwono et al., 2019).

The application of the learning model implemented in class so far is considered capable of increasing students' critical thinking skills. Problem-Based Learning (PBL) is a learning model that is oriented toward the use of problems with real-world contexts that can train critical thinking skills and problem-solving as well as a comprehensive understanding of a material concept PBL can hone critical thinking skills because this model contains activity steps that require students to carry out discussions, exploration, inquiry, discovery, and problem-solving (Agustina et al., 2017; Ali, 2019; Benedicto & Andrade, 2022; Benediktus Tanujaya et al., 2017; Cheng & Liu, 2015; Dharma et al., 2020; Dwi Anggriani & Eko Atmojo, 2022; Fadilla et al., 2021; Hikmawati & Suryaningsih, 2020; Pramestika et al., 2020; Serezli et al., 2023; Widyatingtyas et al., 2015). In other words, learning steps with this PBL model have the potential to improve students' mathematical critical thinking skills. In addition, the use of contextual problems that are close to students' daily lives will also train them to think critically to find the best solution to the problem.

The purpose of implementing the PBL model is to advance the level of critical thinking skills and problem-solving. The results of the study stated that students who experienced the PBL learning model had better problem-solving competencies than conventional models (Lelapary, 2022; Yohannes et al., 2021). Various PBL lessons have been shown to be effective in stimulating mathematical students' critical thinking regarding the material of linear equations (Tyas & Purnomo, 2016). However, there is still a lack of research showing the level of effectiveness of PBL in supporting the development of thinking in class VI students on circle material. Based on this description, the focus of this study on the application of the PBL model is reviewed for its effect on the critical thinking skills of sixth-grade elementary school students. Therefore, PBL will be applied in class VI mathematics learning on circle material and then compares to the achievement of student learning objectives before and after implementing PBL. This research can be the basis for the application of PBL, steps, and new things that arise when learning is mainly about circle material in class VI SD.

METHODS

This study is used pre – experimental research design by grup Pretest-posttest Research Design. Experimental Research Design is an example of a quantitative research method because it involves gathering quantitative data and conducting statistical analysis for the research purpose.(Back & Hwang, 2005; Bruinsma & Weisburd, 2007; Krass, 2016; Toulany et al., 2013; Zhu et al., 2014). The population of this study was students of SDN 173270 Siborong – Siborong, North Tapanuli Regency, North Sumatra Province.

The sample of this research is students of class VI at SDN 173270 siborong - siborong with a total of 25 students.

The research process was carried out through the implementation of PBL which lasted for fourteen hours of lessons. In the first syntax related to problem orientation, students identify everyday problems related to circles through the display of pictures and videos. In the second syntax, namely orientation to the problem, students identify surrounding objects that utilize circular shapes and their parts. Then students in groups solve daily problems related to parts and circles by identifying each element in the problems presented. Students with teacher guidance present a problem-solving report by displaying the identification results. At the end of the syntax, each group of students will display the results of the discussion to obtain responses from other groups.

The data in the study were obtained through tests. The test was carried out through questions that were completed by students before and after experiencing Circle material learning using the PBL model. The instrument used was a multiple-choice question with a total of 10 items to measure critical thinking skills in mathematics circle material for grade VI Elementary School. The instrument was developed by modifying the OECD critical thinking indicators (Harris et al., 2022). The indicators are modified according to the basic competencies of Circle material in grade VI. The instrument has gone through an expert validity test from the mathematics teacher and through discussions with colleagues.

Furthermore, a critical thinking measuring instrument was designed on circle material which is valid from the point of view of content validity. The measuring tool aims to determine the level of critical thinking related to problems involving circular geometry in class VI. This study involved descriptive analysis to measure the influence of applying the PBL model to learning mathematics for class VI on circle material. The statistical technique used as a prerequisite test on paired samples is the normality test. While testing the hypothesis using paired sample t-test.

RESULTS & DISCUSSION

The focus of this research is to analyze changes in the level of critical thinking competence achieved by class VI students in circle material before and after participating in PBL model learning. The results of this study are data on student test scores before and after participating in circle material learning using the PBL model. The tests given were developed based on indicators of students' critical thinking skills. The analysis that was carried out first was descriptive analysis to see changes in student test results. In this study, measurements were carried out on pre- and post-learning student learning outcomes, namely the Pre-Test and Post-Test. Data were analyzed using descriptive analysis techniques.

Table 1. Results of descriptive analysis

	Pre - test	Post - test
Mean	34,80	73,60
Std. Deviasi	17,82	15,51
Nilai Terendah	10	40
Nilai Tertinggi	70	100
Varian	317,67	240,67

Based on Table 1, it appears that the average pretest score is 34.80 while the average post-test result is 73.60. Based on these average results, it appears that there is an increase in critical thinking skills. So, it can be concluded that there is an increase in the critical thinking competence achieved before and after learning using the given PBL model. For the normality test by researcher used the Shapiro-Wilk test because the participants did not reach 30. Hypothesis the basis for testing the normality of the data is: H_0 : Data is normally distributed; H_1 : The data is not normally distributed. The results of the normality test for critical thinking data are listed in Table 2.

Table 2. Result of Normality Test

Kel.	Sig	α	Intepretasi
Pretest	0,62	0,05	normal
Post test	0,18	0,05	normal

Based on Table 2, the data on the results of critical thinking at both the pretest and posttest stages yielded a sig value of more than 0.05 on the Shapiro-Wilk test, so that a decision was made to accept H_0 . Thus, it can be interpreted that the data is normally distributed so that the analysis can be continued using the t-test. The goal is to compare paired sample values. The one-sample t-test is used to test whether the average of a variable has a statistically significant difference when compared to the known average value as an assumption or hypothesized value. In this study, we want to know whether the average value of students' critical thinking is significantly different or not. The research hypothesis is as follows. H_0 : There is no significant effect of the application of PBL on critical thinking skills in mathematics of sixth-grade elementary school students. H_1 : There is a significance in the application of PBL to the critical thinking skills of students in grade VI SD.

This section will be reviewed, The hypothesis written "influence" in the context of this research is the impact Is there a significant difference between the two tests? After applying the PBL model, the analysis used a statistical test, namely the paired t-test where arising from the application of PBL in such a way as to produce a significant difference between the results of the pre-test and post-test. The results of the t-test performed are presented in Table 3.

Table 3. T - Test

Pair 1	Pretest- posttest	Mean	Std. Dev	Std. Err Mean	95% Confidence		t	df	Sig (2- tailed)
					Interval of the Difference				
					Lower	Upper			
		-38,80000	18,33030	3,66606	-46,36638	-31,23362	-10,584	24	0,000

Based on Table 3, processing the critical thinking t-test gets a sig value of less than 0.05 so reject H_0 . Based on the test results on the equal variances assumed section, it appears that the value of Sig (2-tailed) $< \alpha$ is $0.000 < 0.05$. So, H_0 is rejected. The final conclusion is that there is a significant effect of the application of PBL on critical thinking skills in mathematics of sixth-grade elementary school students. The purpose of applying the PBL model is a form of support in training critical thinking, the ability to work together, and involve students in learning. In pre-research, instrument validation is required. In the validator's opinion, it was concluded that the research instrument designed was in the valid category in terms of content validation. The results obtained are that there is an effect of the application of PBL on the critical thinking skills of students

in grade VI SD. After testing the hypothesis, there is an influence between the application of PBL on students' critical thinking skills in mathematics in circle material. The forms of changes that occurred before and after the implementation of PBL can be seen in Figure 1

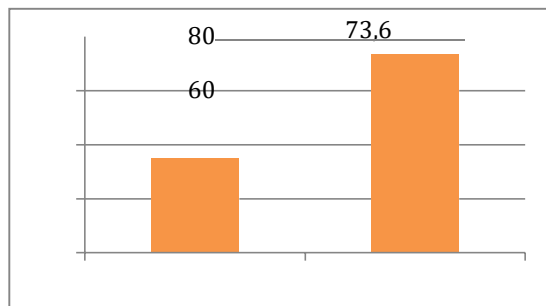


Figure 1. Critical thinking skills chart

Based on Figure 1, it can be seen that the critical thinking competency capacity changes to be more optimal before and after implementing the PBL model. The results of the descriptive analysis of the minimum score in the Pre-Test is 10 while the maximum is 70. In the Post-Test, the minimum score is 40 and the maximum is 100. The average pretest score is 34.80 while the average post-test score is 73.60. The standard deviation value for the pre-test is 17.823 while the post-test is 16.803. So, there are differences in the level of critical thinking skills before and after learning the PBL model. Thus, the application of the PBL model is considered effective in supporting the critical thinking skills of grade VI students, especially in material circles. Student activities in problem-solving are carried out in groups with 3 to 3 members. 4 people. The formation of groups is guided by the teacher so that group members are heterogeneous. Heterogeneous groups are expected to create a collaborative atmosphere. Group activities open opportunities for discussion and sharing of knowledge. The process of sharing knowledge supports stimulating efforts for students to convey ideas and ideas and criticize each other through trials.

Student discussion activity is one aspect of critical thinking skills. These results are relevant to the conclusions of the study which show that PBL is able to have a good impact on improving critical thinking skills through the process of problem analysis and knowledge sharing between students (Benedicto & Andrade, 2022; Dharma et al., 2020; Dwi Anggriani & Eko Atmojo, 2022; Fadilla et al., 2021; Pramestika et al., 2020). In addition, the group discussion process is also able to support the improvement of students' critical thinking skills (Maryani et al., 2018). PBL is a learning model with student-centered syntax. Through PBL, students are actively involved in identifying solutions to problems that are presented either personally or collaboratively. This process helps develop students' critical thinking in learning mathematics (Agustina et al., 2017; Ali, 2019; Dharma et al., 2020; Hikmawati & Suryaningsih, 2020).

Student activity in problem-solving involves objects around, the application of the PBL model by involving problems and concrete objects around causes students to actively find solutions to the mathematical problems presented. This finding is supported by research results which show that PBL accompanied by the use of concrete objects supports the improvement of students' critical thinking skills in mathematics (Pramestika et al., 2020)

The results of group discussions are then translated in class to get suggestions and responses from other group members. This activity provides an opportunity for students to evaluate the solutions that have been implemented. In this activity, students have the

opportunity to be actively involved in class discussions. In class discussion activities, students are also actively involved in efforts to evaluate the solutions to problems presented by their classmates. Students have the opportunity to analyze the possibility of differences of opinion and detect new findings related to the problem-solving ideas presented. Thus, students will be stimulated in conducting evaluations. The next activity is group presentations, this activity trains students to evaluate the problem-solving that has been done as one of the indicators developed in critical reasoning skills (Changwong et al., 2018).

From the results of research and discussion, the PBL application has a significant impact on student's critical thinking skills related to class VI circle material. Mathematics with a non-concrete object of study requires the right strategy so that students are supported to strengthen their critical thinking skills. The results of the study prove that the application of PBL can improve the critical thinking skills of grade VI students. PBL supports students in carrying out independent solution-finding activities through the process of finding and gathering information, group discussions, trials, and delivering results. These activities support various competencies and student potential related to achieving learning goals, improving the quality of communication, collaborative activities in class, and efforts to be tolerant in dealing with differences of opinion. PBL gives students the opportunity to learn to deal with real situations in everyday life. This activity tends to be inversely proportional when the teacher dominates the lesson. The dominance of the teacher in the class has an impact on the lack of student effort in engaging in the thinking and learning process. Less optimal thinking activities do not support efforts to develop students' critical thinking skills.

CONCLUSION

Based on the results of the research and discussion, there is an effect of the application of PBL on efforts to support critical thinking skills in mathematics of sixth-grade elementary school students. Learning activities activate students and expanding the learning media used are factors that support the improvement of students' mathematical critical thinking skills. Based on these conclusions, this study proposes several suggestions for future improvements. In this study learning using the PBL model in order to improve critical thinking. Future research is expected to be able to develop effective PBL implementation efforts on other materials that support critical reasoning activities. However, the implementation of PBL requires quite a long period of time, so it is necessary to conduct more specific research on other variables that influence the success of PBL.

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