JCAR 7(1) (2025)

Journal of Classroom Action Research

http://jppipa.unram.ac.id/index.php/jcar/index

The Influence of the PBL Model on Students' Critical Thinking Skills in Science Learning

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DOI: https://doi.org/10.29303/jppipa.v6i1.264

Received: 29 Desember 2024 Revised: 23 Februari 2025 Accepted: 28 Februari 2025

Abstract: This research aims to determine the influence of the Problem-Based Learning (PBL) Model on students' Critical Thinking Skills in science learning. This research method is experimental, with a pretest-posttest control group design. The population in this study was class VII at SMP Negeri 4 Gorontalo for the 2024/2025 academic year. The sample consists of 2 classes, namely the experimental and control classes, using the Simple Random Sampling technique. Data collection uses a critical thinking skills test in the form of an essay consisting of 10 questions. Data collection techniques use normality tests, homogeneity tests, hypothesis tests, and N-Gain tests. Data normality testing show that Fi ≥ K for the actual level α = 0.05, which were normally distributed. Data homogeneity testing show that the value of F-count < F-table, so it can be concluded that H0 is accepted and the data is homogeneous. The value T-count > T-table is obtained where T-count is 2.02 and T-table 2.01, meaning that H0 is rejected and H1 is accepted. Meanwhile, the average value of the N-gain test for the experimental class was 78.3 (high), while the control class was 70.3 (medium). Therefore, the researcher concluded that the PBL model influenced students' critical thinking skills in science learning.

Keywords: PBL model; Critical Thinking Skills; Science learning.

Introduction

Education is important, lasts a lifetime, and cannot be separated from human life. It is a collective responsibility and not an individual matter, so education is collective. Education cannot be separated from the interaction of an educator and students, which will later become a learning process (Permatasari et al., 2019). In the 21st century, the development of science and technology, especially in information and communication, is growing rapidly. Apart from that, competition in this era of globalization is also very tight. This intense competition has affected all aspects of life, including in the field of education. Education is essential to develop students' attitudes, knowledge, and skills because education is a program that contains objective components and a teaching and learninzase3d5g process between students and teachers, which will improve human resources for the better. To achieve a good education, one of the subjects that has a strategic role for human resources, especially students, is science subjects (Sukawati et al., 2020).

Science studies the symptoms, events, and natural phenomena that occur in it. It is not just theoretical knowledge but knowledge in the form of facts, concepts, principles, and discoveries made from the results of actual and direct human activities. A teaching and learning process is good if it can generate practical learning activities that can be carried out well to achieve the desired learning outcomes. The reality shows that the teaching and learning process in schools still requires many improvements in the learning system (Bada & Olusegun, 2015).

Based on the results of observations carried out at SMPN 4 Gorontalo in March 2024, especially in science subjects, many students are still unable to relate

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scientific knowledge to phenomena that occur in everyday life. This is because students only memorize concepts from theory without any understanding. Students' lack of interest in studying science because it is considered difficult and tedious results in low student learning outcomes. There is a lack of student activity in responding to learning; students only act as listeners while the teacher is still the leading actor in learning. There is no student participation to play an active role in education, especially since students' critical thinking skills are still very low; many are passive, less active, and shy about expressing opinions during learning.

Critical thinking is not necessarily inherent in a person from birth. However, critical thinking is a skill that can be developed through students' direct experience in dealing with problems (Fadholi & Mahmud, 2024). They can also consider their own opinions (Nasution, 2019). As a result, learning in schools must teach students how to search for, process, and evaluate data critically. This is relevant to the consideration (Artayasa, et al., 2024) that critical thinking is an expected ability and a necessary tool for constructing knowledge. The teacher's task to improve students' critical thinking skills is to provide a learning environment that can encourage students to use thinking skills. One of the factors that determines the success of developing students' critical thinking skills is expertise in choosing and using appropriate learning models (Agustin & Nurul, 2017).

Prihono and Khasanah (2020) state that critical thinking is an effort to express responses in a reflective and reasoned manner that is decided to validate decisions that have been believed and tried. So, critical thinking is a structured process within oneself that allows students to analyze and assess facts and the language that underlies other people's statements. Meanwhile, Syutharidho and Rakhmawati (2015) explained that critical thinking is a habit indicated by enthusiasm for learning more or trying to capture lessons well when expressing opinions or conclusions.

A learning model can facilitate the formation of students' critical thinking skills is the problem-based learning (PBL) model. The PBL allows schools to be independent, increase self-confidence, improve their skills and interests, and organize their knowledge (Supriatna, 2020). The PBL model is designed to help students develop their critical thinking and problem-solving skills. Hardiatiningsih et al. (2023) stated that applying the stages in the PBL model increases students' critical thinking abilities because they are more active and involved in the learning process. In the PBL model, several stages greatly influence training students' abilities to think actively and critically. So critical thinking in solving problems through the PBL model is a learning model that is very suitable for use in science learning (Rahmatia et al., 2024). Based on the background description above, researchers are interested in conducting research with the topic about the PBL model to determine influence of students' critical thinking skills on science learning.

Method

The research type is experimental, and the research design used is the Pretest-Posttest Control Group design in Figure 1. This design was applied to two different classes, namely the experimental class and the control class. Before the treatment, the two classes were given an initial test (Pretest), and after the treatment, the two classes were given a final test (Posttest). The research population was class VII students of SMP Negeri 4 Gorontalo for the 2024/2025 academic year. This research took samples using simple random sampling techniques. The experimental class and control class were determined randomly by drawing lots. The selected samples were class VII-6 as the experimental class and class VII-5 as the control class.

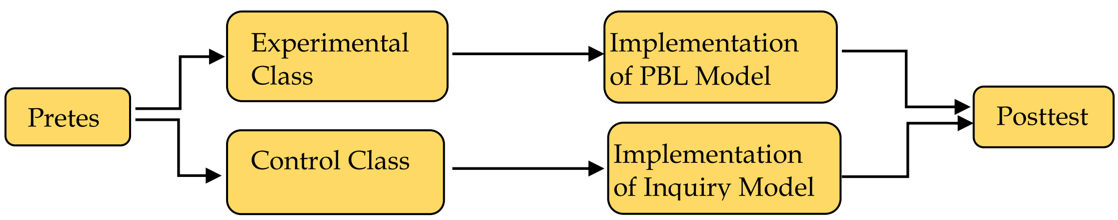

Figure 1. The flow chart of research

The instrument of this research is a test of students' critical thinking skills. The instrument used is in the form of an essay with 10 questions. The test instrument is in the form of essay questions to measure students' critical thinking skills on physical and chemical changes material given during the pretest and posttest. The scores obtained from the critical thinking skills test were then subjected to data analysis, including a normality test, homogeneity test, hypothesis test, and n-gain test, to determine the effect of the PBL model on students' critical thinking skills in science learning.

Result and Discussion

The results of this research data were obtained from pretest and posttest scores, which showed an increase in students' critical thinking skills. This data was analyzed using the normality, homogeneity, N-gain, and hypothesis tests. The data results were pretest-posttest scores based on essential thinking indicators for the experimental and control classes in Table 1.

Table 1. Results of Student Critical Thinking Skills

Code	Critical Thinking Skills Indicators	Experimental (%)	Control (%)
AA	Provide a simple explanation	8.36	8.92
AB	Build basic skills	9.48	8.08
AC	Drawing conclusions	8.68	8.84
AD	Provide further explanation	9.56	8.68
AE	Set strategy and tactics	9.64	8.36

Based on Table 1, it can be seen the percentage results of critical thinking skills for each indicator after being given treatment in the experimental class, which was taught using the PBL model, with the percentage results in the control class, which was taught using the Inquiry model, where the average comparison for each indicator of critical thinking skills in the experimental class was higher than in the control class.

This research is in line with previous research, the first conducted by (Surya, et al 2014) entitled "Application of PBL to improve students' critical thinking skills at SMAN 11 Banda Aceh." The research results show a significant difference in the increase in students' critical thinking in the experimental class compared to the control class at the level = 0.05, namely T-count > T-table (3.8>1.67). Second (Nafiah & Suyanto, 2014). The results of implementing the PBL Model it can increase students' critical thinking skills in learning by 24.2%. The graph for critical thinking skills for each indicator can be seen in Figure 2.

Based on Figure 2, the percentage of test results for each indicator of students' critical thinking skills after treatment in the experimental and control classes, where the average comparison for each indicator of critical thinking skills in the experimental class is higher than that of the control class. The indicator providing a simple explanation for the control class has a higher value than the experimental class, namely 8.92. This is because students in the experimental class still struggle to understand the teacher's guidance and direction in increasing student involvement and activeness during the learning process.

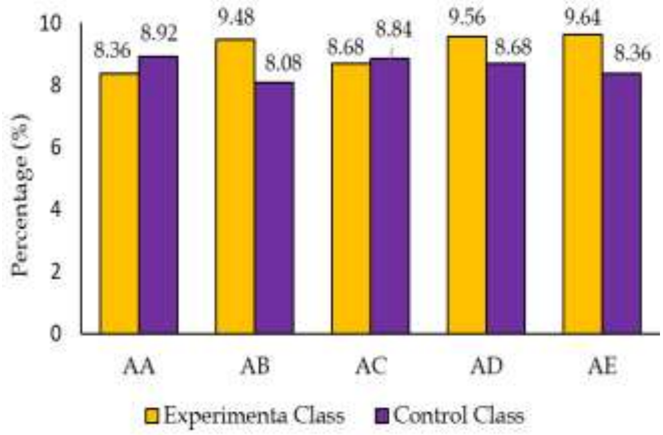

Figure 2. Critical thinking skills for each indicator

Students' skills in understanding questions are not good, whereas, in the control class, students can understand and improve their skills in understanding the questions, and students can be involved with each other in the learning process so they can understand the questions well. The indicator for building essential skills for the experimental class received a higher score of 9.48 because students are trained to formulate problems by writing down what they know and what is asked in the questions. In this indicator, students can respond to questions using the control class's inquiry learning model.

The indicator concluded that the control class obtained a higher score using the Inquiry learning model, 8.84. This was because students in the experimental class were still less able to analyze and write conclusions about the answers to the questions. The indicator providing further explanation for the experimental class has a higher value than the control class, namely 9.56; this is because students understand the questions very well and understand what is meant by the questions so that they can provide further explanations correctly.

The experimental class's indicator for managing strategies and tactics received a higher score, 9.64, than the control classes. In this indicator, students could organize appropriate strategies and tactics to solve a problem. Based on the percentage of test results for each indicator of students' critical thinking skills, it was found that of the five indicators of critical thinking skills measured, one indicator had a higher percentage, namely the indicator for managing strategies and tactics, and the lowest indicator was building essential skills. The indicator of managing strategies and tactics is the stage where students can organize appropriate strategy and tactics to adapt a problem so that they can solve and evaluate the solutions used.

The results of this research align with previous research; the indicators for building basic skills are included in the low percentage category, with the lowest percentage of all indicators of critical thinking skills. This indicator regulates strategies and tactics included in the high percentage criteria (Fatma et al., 2019). In line with Ramdani, et al (2021) stated that in training critical thinking skills, it is necessary to present events in the form of images so that they can provide good essential results of thinking. Based on this, the indicators for managing strategies and tactics can improve students' critical thinking skills. The percentage of achievement results for managing strategy and tactics in the experimental class is 9.64, and in the control, class is 8.36.

This research is in line with Rahmawati et al. (2016), who stated that the indicators for managing strategies and tactics are included in a good percentage, and Utomo & Wihartanti, (2019) noted that the indicators for managing strategy and tactics are included in a very high category compared to other indicators of critical thinking skills. In contrast to Miftah's (2013) research results, the indicators for managing strategy and tactics are included in the low category with low values for all indicators.

Normality Test

Data normality testing aims to determine whether the data is normally distributed. This research uses the Kolomogrof-Smirnov normality test formula using Microsoft Excel. The data normality test results obtained can be seen in Table 2.

Table 2. Data Normality Test Results

Class	Fi	K	Information
Experimental	0.48	0.26	Normally distributed
Control	0.48	0.26	Normally distributed

Based on Table 2, the results of data normality testing show that Fi ≥ K for the actual level $\alpha = 0.05$, which the values Fi is 0.48 and K is 0.26 for experimental class. In control class, Fi is 0.48 and K is 0.26. The both of classes have the same values. To test data normality, data was obtained for all samples in both experimental and control classes, which were normally distributed. Thus, because the data is normally distributed, homogeneity testing using the f test with the help of Microsoft Excel is continued to determine whether the data obtained is homogeneous or not.

Homogeneity Test

The homogeneity test in this research was carried out to determine whether the data was homogeneous. The test consists of pretest and posttest to determine F-count and F-table. The results of homogeneity test in Table 3.

Table 3. Data Homogeneity Test Results

Test	F-count	F-table	Information
Pretest	1.0488	1.9838	Homogeneous
Posttest	1.9810	1.9838	Homogeneous

Based on Table 3, the results of data homogeneity testing show that the value of F-count < F-table, so it can be concluded that H0 is accepted and the data is homogeneous. Thus, because the data is homogeneous, the test continues with statistical testing using the t-test. Suppose a sig value is obtained. Data for both the experimental and control classes is ≥ 0.05, and it can be concluded that the data is normally distributed, and the data is said to be homogeneous if the sig. The experimental and control posttest data was obtained at > 0.05, and then the data was homogeneous (Mariskhantari et al., 2022).

Hypothesis Testing

Hypothesis testing aims to determine whether the PBL model influences students' critical thinking skills in science learning. This research uses the independent sample t-test formula using Microsoft Excel. The independent sample t-test in this research was carried out to prove the truth of the research hypothesis. The test criteria are if the sig. < 0.05, then there is a significant difference between the average pretest and posttest scores, or Ho is rejected. Then, if the sig value. > 0.05, then there is no significant difference between the average pretest and posttest scores, or Ho is accepted (Rizky et al., 2024). The hypothesis testing results obtained shows in Table 4.

Table 4. Hypothesis Testing Results

T-count	T-table	Information
2.02	2.01	H_0 rejected

Based on the Table 4, the value T-count > T-table is obtained where T-count is 2.02 and T-table 2.01, meaning that H0 is rejected and H1 is accepted because T-count > T-table. It H1 is accepted because the PBL model influences students' critical thinking skills in science learning. This proves that this research improves students' critical thinking skills.

N-Gain Test

The N-gain test is carried out to determine how much students' critical thinking skills have improved by calculating the pretest-posttest scores. N-gain analysis of test results using the course average normalized gain in the experimental and control classes as shown in the following in Figure 3.

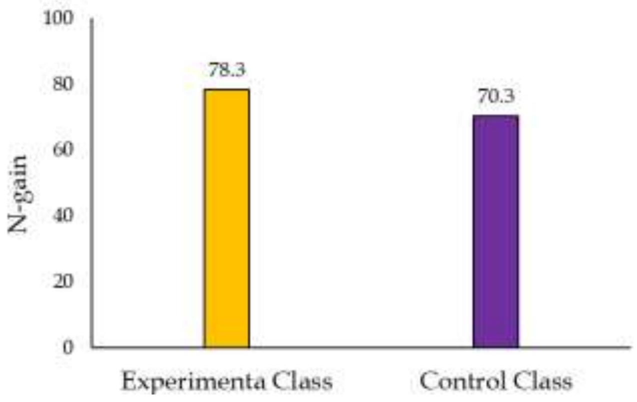

Figure 3. Average of experimental and control classes

Based on Figure 3, the average value of the N-gain test for the experimental class was 78.3 (high), while the control class was 70.3 (medium). So, the student's critical thinking skills in the experimental class are high, while those in the control class are medium. Based on these results, researchers can conclude that PBL models influence students' critical thinking skills in science learning. These results mean that applying the PBL model can improve the critical thinking skills of class VII students at SMP Negeri 4 Gorontalo on the material of physical and chemical changes for the 2024/2025 academic year. With the results of this research, the researcher concluded that the PBL model is very suitable to be applied because this learning provides opportunities for students to be directly involved in problem-solving (actively) so that it ultimately has an impact on increasing students' critical thinking abilities. The results of this research are also strengthened by previous research conducted by Sukmawati (2020), which stated that learning by applying the PBL model can improve critical thinking skills. This is because students' activities to think critically and solve problems are supported by the learning atmosphere when the PBL model is applied.

Conclusion

The results of research that has been conducted using experimental research methods, experimental classes, and control classes show that the PBL model can influence students' critical thinking skills in science learning. Data normality testing show that Fi ≥ K for the actual level $\alpha = 0.05$, which were normally distributed. Data homogeneity testing show that the value of F-count < F-table, so it can be concluded that H0 is accepted and the data is homogeneous. The value T-count > T-table is obtained where T-count is 2.02 and T-table 2.01, meaning that H0 is rejected and H1 is accepted. Meanwhile, the average value of the N-gain test for the experimental class was 78.3 (high), while the control class was 70.3 (medium). Therefore, the researcher concluded that the PBL model influenced students' critical thinking skills in science learning. Thus, this research was declared successful (H1 was accepted).

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