

**THE INFLUENCE OF THE PROBLEM-BASED LEARNING (PBL) MODEL ON THE
CRITICAL THINKING SKILLS OF JUNIOR HIGH SCHOOL STUDENTS IN SCIENCE
LEARNING**

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ABSTRACT

The purpose of this study is to examine the effect of the Problem-Based Learning (PBL) model on students' critical thinking skills in science learning and the improvement in students' critical thinking skills following the implementation of the Problem-Based Learning (PBL) model. This study employed a quasi-experimental research method using a non-equivalent (pretest-posttest) control group design. The population of this study consists of seventh-grade students at SMP Negeri 4 Jember for the 2025/2026 academic year, with Class VII B serving as the experimental class and Class VII C as the control class. The results indicate that, descriptively, the posttest mean score for the experimental class (74,66) was higher than that of the control class (68,91). The Independent Sample T-test yielded a significance value of 0,126 (Sig. > 0,05), indicating no statistically significant difference between the two classes. However, the N-Gain test result showed an improvement in critical thinking skills in the experimental class, falling into the moderate category with an average score of 0,5207. The self-regulation indicator showed the highest improvement, while the explanation indicator showed the lowest improvement. It is concluded that the problem-based learning model can make a positive internal contribution to students' critical thinking skills, even though it has not yet yielded a statistically significant difference.

Keywords: Critical Thinking Skills; Problem-Based Learning; Natural Sciences.

Submitted: 18 July 2026	Accepted: 07 September 2026	Published: 26 September 2026
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INTRODUCTION

Science education is not merely the transfer of knowledge regarding principles of facts, but rather scientific process for understanding natural phenomena through systematic observation and reasoning (Supriana et al., 2023). In the context of 21st-century education, critical thinking skills are positioned as essential advanced cognitive competencies that enable students to analyse, evaluate, and make logical decisions based on the information they have obtained (Azisah et al., 2023). The importance of developing these skills aligns with the demands of Higher Order Thinking Skills (HOTS), which focus not only on mastery of subject matter but also on developing the mindset needed to solve contextual problems faced by students (Putri et al., 2026).

However, the reality on the ground shows that junior high school students' critical thinking skills remain relatively low. Various studies indicate that students' critical thinking performance in several regions of Indonesia is still predominantly in the low category (Widyapuraya et al., 2023). Initial observations at SMP Negeri 4 Jember confirm this situation, where learning tends to be conventional, teacher-centered, and prioritizes memorization over critical reasoning (Ernaini et al., 2021). This situation class for instructional innovations that can stimulate students' active engagement in the scientific thinking process.

The problem-based learning (PBL) model is considered effective as an approach for developing essential 21st-century skills, particularly critical thinking (Masrinah et al., 2019). The PBL model can be defined as a learning model that prioritizes students' active participation in critical reasoning and their ability to consistently analyze problems (Tiara et al., 2024). In its implementation, students are presented with real-word problems encountered in daily life, thereby encouraging them to identify problems, gather information, analyse data, and formulate solutions.

The Problem-Based Learning (PBL) model offer a solution through a constructivist approach that trains students to solve real-word problems independently (Sidampoi et al., 2024). The implementation of the PBL model using a scientific approach has been empirically proven to have a significant impact on improving students' critical thinking skills in learning (Alkamalia, 2025). Through the PBL process form problem orientation to evaluation students are encouraged to engage in authentic learning experiences, so that they do not merely receive information but actively construct their own knowledge.

This study aims to analyse the effect of the PBL model on the critical thinking skills of junior high school students in science lessons on the topics of temperature and heat, as well as to measure improvements in critical thinking skills through Normalized Gain (N-Gain) analysis. Although various previous studies have shown that PBL can improve students' critical thinking skills, the results of its implementation still vary across different learning contexts and student characteristics. Therefore, this study is important to obtain an empirical picture of the effectiveness of PBL in improving the critical thinking skills of junior high school students. The hypothesis of this study is that there is a significant effect of the Problem-Based Learning model on students' critical thinking skills compared to conventional learning.

RESEARCH METHODS

This study was conducted at SMP Negeri 4 Jember during the second semester of the 2025/2026 academic year. The study population consisted of all seventh-grade classes at the school, while the sample was drawn from two classes; Class VII B, which served as the experimental group, and Class VII C, which served as the control group. The sample was selected using random sampling. A non-equivalent (pretest-posttest) control group design was applied in this study, in which two groups of students were given different treatments. The experimental class received Problem-Based Learning (PBL), while the control class continued to use the conventional teaching methods in place at the school.

Data collection in this study utilised two types of data: primary and secondary data. Primary data included critical thinking test results collected through pretests and posttests. Secondary data was obtained through observations to gather information regarding the initial conditions of the seventh-grade class prior to the study, interviews with the school's science teacher, and documentation in the form of photos, videos, and student data collected during the research process. Data analysis was conducted in several stages. Critical thinking skills were assessed using a percentage calculated as follows:

$$\text{Percentage}(Pk) = \frac{\text{Jumlah score obtained}}{\text{maximum score}} \times 100\%$$

The data analysis of the effect of students' critical thinking skills in this study utilized three statistical tests: the normality test, the homogeneity test, and the hypothesis test. The normality test employed the Shapiro-Wilk method because the sample size was less than 50 (Ghasemi et al., 2012). The data were considered normal if the significance value obtained was $> 0,05$, and the data were considered non-normal if the significance value obtained was $< 0,05$. The homogeneity test was conducted using Levene's Test for Equality of Variances in SPSS based on the results of previous science exams. The data were considered homogeneous if the significance value was $< 0,05$.

This study used an Independent Sample T-test to measure critical thinking skills. If the significance level is $> 0,05$, then H_0 is accepted and H_1 is rejected. Conversely, if the significance level is $< 0,05$, then H_0 is rejected and H_1 is accepted (Fridayani & Kusuma, 2023). The hypothesis tested is H_0 , which states that there is no significant difference between the mean critical thinking skills of students in the experimental class and the control class. Meanwhile, H_1 states that there is a significant difference between the mean critical thinking skills of students in the experimental class and the control class.

The Normalized Gain (N-Gain) test was used to assess the increase in students' critical thinking scores following the implementation of the learning model. Critical thinking skills were analyzed using the N-Gain formula as follows:

$$(g) = \frac{\text{posstest mean score} - \text{pretest mean score}}{\text{maximum score} - \text{pretest mean score}} \times 100\%$$

Table 1. Hake's (1998) N-Gain average Score Criteria

Score	Criteria
$(g) \geq 0,7$	High
$0,7 > (g) \geq 0,3$	Moderate
$(g) < 0,3$	Low

RESULTS AND DISCUSSION

This study was conducted at SMP Negeri 4 Jember during the 2025/2026 academic year. The learning process took place over four sessions, from January 5 to January 15, 2026. The study sample consisted of two classes: Class VII B as the experimental class and Class VII C as the control class, each with 32 students.

Student's critical thinking skills were assessed using a test instrument consisting of six open-ended questions aligned with critical thinking indicators. The research data were obtained from students' pretest and posttest scores. The average pretest and posttest scores for both classes are shown in Table 2.

Table 2. Mean pretest and posttest scores for critical thinking skills

Group	Pretest	Posttest
Experimental	49,19	74,66
Control	49,81	68,91

The results of the Independent Sample T-test are shown in Table 3.

Table 3. Results of the Independent Sample T-test

Independent Sample Test									
Lavene's Test for equality of Variances				t-test for Equality of Means					
									95% Confidence interval of the Difference
	F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error Difference	Lower	Upper
Critical Thinking	Equal variances assumed	0,182	0,671	1,551	62	0,126	5,750	3,708	-16,662 13,162

Based on Table 3., the results of Levene's Test for Equality of Variances show an F-value of 0,18 with a p-value of 0,671. Since this p-value is greater than 0,05 ($0,671 > 0,05$), the data variances between the two classes are considered homogeneous or equal. However, the Independent Sample T-test showed a significance value (2-tailed) of $0,126 > 0,05$, indicating no statistically significant difference between the experimental and control classes. Based on the decision criteria, H_0 is accepted and H_1 is rejected.

Improvements in students' critical thinking skills were analysed by measuring the categories of score improvement using the N-Gain test. The aim was to determine the effectiveness of the treatment based on the differences in the mean pretest score and posttest score of the students. The results of the N-Gain test for students' critical thinking skills in the experimental class are attached as follows:

Table 4. Results of the N-Gain Test for Critical Thinking Skills in the Experimental Class

Group	Pretest	Posttest	N-Gain	Criteria
Class Experimental	49,19	74,66	0,5207	Moderate

Based on the Table 4., the N-gain score obtained was 0,5207, which falls under the moderate criterion. This was calculated using a pretest score of 49,19 and a posttest score of 74,66 for the experimental class group.

The results of the study indicate that the implementation of the Problem-Based Learning (PBL) model has not had a significant effect on students' critical thinking skills, as evidenced by the Independent Sample T-test, with a significance level (2-tailed) of $0,126 > 0,05$. These results indicate that there is no significant difference in critical thinking skills between the experimental and control classes after the intervention was administered. Thus, the research hypothesis is rejected, and the implementation of PBL in this study has not been able to demonstrate a significant effect compared to conventional learning.

The lack of significant research results may be influenced by several factor, one of which is the relatively short duration of implementation, consisting of only four sessions. Critical thinking skills are higher-order cognitive abilities that require a transformation in mindset, not merely the imparting of knowledge. In line with Nurfitriyanti (2016), students need time to adapt from passive learning patterns to critical, self-directed learning patterns. The limited research time hindered the test instrument from capturing drastic changes in reasoning structures, given that Putri et al. (2024) emphasize that improving critical thinking skills requires continuous practice. Therefore, the limited implementation time was likely insufficient to produce significant changes in critical thinking skills.

Nevertheless, the N-Gain analysis showed that the critical thinking skills of students in the experimental class improved by 0,5207, which falls into the moderate category. These findings indicate that PBL continues to make a positive contribution to the development of students' critical thinking skills, even though this improvement was not significantly different from that of the control class. These results are consistent with Fakhriyah (2014), who states that problem-based learning is capable of encouraging students to engage in the processes of analysis, evaluation, and solution formulation through systematic problem-solving activities.

Base on the analysis by indicator, the highest improvement occurred in the self-regulation indicator, with an N-Gain value of 0,57. This finding suggests that PBL can help students develop independent learning through inquiry-based activities and independent information-seeking. Hmelo-Silver (2004) explains that a key characteristic of PBL is promoting self-directed learning, thereby encouraging students to make a more active role in managing their own learning process. Conversely, the lowest increase occurred in the explanation indicator with an N-Gain value of 0,43. These results indicate that students still experience difficulties in communicating ideas and constructing scientific arguments systematically. Osborne et al. (2004) state that scientific argumentation skills require continuous practice because students must be able to logically connect claims, evidence, and reasons.

Overall, the research findings indicate that the implementation of the PBL model has the potential to support the development of students' critical thinking skills. However, a longer-term and sustained implementation is necessary for the learning outcomes to be significantly evident. These findings are supported by Sidampoi et al. (2024), who demonstrated that the systematic application of Pbl can enhance students' critical thinking skills in science education.

These research results are also consistent with Mariskhantari et al. (2022), who found that students' active engagement in the process of inquiry and problem-solving promotes the improvement

of critical thinking skills. Thus, although it has not yet shown statistically significant differences, the PBL model remains a viable option for developing students' critical thinking skills regarding temperature and heat.

CONCLUSIONS

Based on the research results, the implementation of problem-based learning (PBL) did not show a significant effect on the critical thinking skills of junior high school students regarding the topic of temperature and heat, as indicated by the results of results of the Independent Samples T-test with a significance level (2-tailed) of $0,126 > 0,05$. Thus, there was no significant difference between the critical thinking skills of student in the experimental class and the control class. Nevertheless, the N-Gain analysis results indicate an improvement in critical thinking skills in the experimental class with a value of 0,5207, which falls into the moderate category. This finding suggests that the PBL model makes a positive contribution to the development of students' critical thinking skills. Therefore, the implementation of PBL over a longer and more sustained period id recommended to achieve more optimal results in enhancing students' critical thinking skills.

ACKNOWLEDGEMENTS

The author would like to express his deepest appreciation and gratitude to all parties who have provided support and contributed to the implementation and completion of this study on the effect of the Problem-Based Learning model on the critical thinking skills are extended to the principal of SMP Negeri 4 Jember, the science teachers, and all seventh-grade student students who granted permission, provided assistance, and cooperated throughout the research process, enabling this study to proceed smoothly.

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