

THE EFFECTIVENESS OF PROBLEM BASED LEARNING MODEL IN IMPROVING STUDENTS' CRITICAL THINKING SKILLS AND LEARNING OUTCOMES

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Abstract

This study aimed to examine the effectiveness of the Problem Based Learning (PBL) model in improving students' critical thinking skills and learning outcomes. The study employed a quantitative approach using a quasi-experimental method with a non-equivalent control group design. The research was conducted in [name of school] involving two classes, namely an experimental class and a control class. The experimental class received instruction through the PBL model, while the control class was taught through conventional learning. Data were collected through critical thinking tests and learning outcome tests administered in the form of pretest and posttest, supported by observation and documentation. Data analysis included descriptive statistics, prerequisite tests, independent sample t-test, N-gain analysis, and effect size analysis. The findings indicated that students in the experimental class experienced a more substantial improvement than those in the control class. PBL encourages students to actively engage in identifying problems, discussing ideas, analyzing information, and formulating solutions based on real contexts. These processes contributed to the development of critical thinking and deeper conceptual understanding. Therefore, Problem Based Learning can be considered an effective instructional alternative to enhance students' critical thinking skills and learning outcomes.

Keywords: Problem Based Learning, Critical Thinking Skills, Learning Outcomes, Quasi-Experiment..

INTRODUCTION

Educational advancements in the 21st century require students to possess advanced cognitive abilities, particularly critical thinking skills, which serve as a fundamental foundation for information analysis, decision-making, and rational problem-solving. This competency has emerged as a crucial attribute to be cultivated in the educational process, as it is intrinsically linked to students' readiness to face global challenges and the complexities of contemporary life (Purba et al., 2021; Yu & Zin, 2023). However, empirical observations indicate that students' critical thinking competencies are largely categorized as lacking. This phenomenon is influenced by the dominance of teacher-centered pedagogical practices, which result in reduced opportunities for students to develop autonomous and in-depth cognitive skills (Hutagalung et al., 2023). Furthermore, educational approaches that primarily prioritize direct memorization of concepts, while neglecting critical processes of analysis and evaluation, result in inadequate preparation for students in addressing authentic dilemmas (Herman et al., 2022; Rauf et al., 2022).

Low critical thinking skills also impact student learning outcomes, which are less than optimal. Learning processes that lack active student involvement result in shallow conceptual understanding and difficulty applying it in everyday life (Yusuf Rambe et al., 2024; Panjaitan et al., 2025). This demonstrates that improving learning outcomes is inseparable from developing critical thinking skills as part of higher-order thinking skills. Various studies in the past five years have shown that the Problem-Based Learning (PBL) model is an effective approach to addressing this problem. PBL emphasizes contextual problem-based learning that encourages students to investigate, discuss, and solve problems collaboratively. Through this process, students not only gain knowledge but also develop critical thinking skills sustainably (Risnawati et al., 2022).

THE EFFECTIVENESS OF PROBLEM BASED LEARNING MODEL IN IMPROVING STUDENTS' CRITICAL THINKING SKILLS AND LEARNING OUTCOMES

Surya Octavianus Simbolon et al

Other research also shows that the implementation of PBL has a positive impact on student learning outcomes. Students who learn using the PBL model tend to be more active, able to connect concepts to real-life situations, and have better problem-solving skills compared to students who learn using conventional models (Yusuf Rambe et al., 2024). Similar findings are also supported by research showing a significant increase in critical thinking skills after implementing the PBL model in learning (Risnawati et al., 2022). Furthermore, an international literature review confirms that PBL is an effective approach in developing critical thinking skills, especially when integrated with collaborative, reflective, and authentic problem-based activities. In fact, the results of a systematic review show that PBL adaptations oriented towards developing critical thinking can significantly improve students' analytical, evaluation, and reasoning skills (Yu & Zin, 2023).

Other studies have also revealed that the success of PBL is influenced by the learning design, student engagement, and implementation strategies used in the classroom (Anggraeni et al., 2023; Wijayanto et al., 2023). Furthermore, the integration of technology and metacognitive activities in PBL can further strengthen the development of students' critical thinking skills (Li Lu et al., 2025). Other empirical studies have also shown that PBL has a significant contribution to improving higher-order thinking skills and learning outcomes simultaneously (Ida Bagus Amertha Putra Manuaba et al., 2022). However, several studies have shown that the effectiveness of PBL is not always optimal due to variations in implementation in the field, both in terms of strategy, learning design, and teacher readiness (Hestiningtyas et al., 2021). These observations suggest that there is a distinct difference between the conceptualization of Problem-Based Learning (PBL) as a potentially innovative educational framework and the practical implementation of such a model within the confines of a traditional classroom environment. According to the explanations provided, one can distinguish significant differences between the characteristics of conventional educational settings and the necessary skills demanded by the complexities and challenges of the 21st century. In contrast, PBL has been empirically shown to provide substantial benefits in enhancing critical thinking skills among learners, as well as to positively influence various educational outcomes for students. However, it is worth noting that there is a relative paucity of empirical studies that comprehensively examine these two critical factors within the same educational context, representing a significant gap in the existing literature. Consequently, it is crucial to undertake this research effort with the aim of elucidating the extent to which problem-based learning methodology can effectively enhance students' critical thinking skills and their overall academic performance simultaneously.

METHOD

With a quasi-experimental design, this study used a quantitative approach to empirically test the effectiveness of the problem-based learning (PBL) model on students' critical thinking skills and learning outcomes. Obtaining objective data, represented quantitatively in the form of numerical scores, allowed researchers to engage in comprehensive statistical analysis. Because existing classroom conditions do not allow for total randomization in educational research, the use of a quasi-experiment is a reasonable alternative (Creswell, 2013). The study was conducted at RK Bintang Timur Private Junior High School in the even semester of the 2025/2026 academic year. The study population was students in grades VIII-1, VIII-2, and VIII-3, while the study sample consisted of one class selected purposively based on equivalence of initial abilities. Class VIII-1 was designated as the experimental class with 36 students and class VIII-2 as the control class with 36 students.

In this study, the methodological approach used was a Non-Equivalent Control Group Design. Two distinct groups consisted of an experimental group that received treatment and a control group that did not. The choice of this particular design was based on the idea that conducting a comparative analysis between two groups receiving different treatment protocols can provide a more in-depth and precise understanding of the relative effectiveness of the applied learning models. In this study, the experimental group was subjected to an educational intervention using the Problem-Based Learning (PBL) model. On the other hand, the control group continued to use traditional educational methods. Before the treatment phase began, both groups took a pretest to determine a baseline measure of their abilities. After the treatment phase, they underwent a posttest to evaluate any changes in student abilities caused by the pedagogical intervention. In the field of educational research, this particular design has received considerable attention and is widely used. This is primarily because it can explain how various learning interventions impact real classroom environments (Yusuf Rambe et al., 2024). Students of SMP Bintang Timur Pematangsiantar in equivalent classes were selected for this study through saturation sampling, a non-probability sampling technique. This method was chosen based on the limited population, meaning everyone in the population could be sampled. Considering the equality of students' initial abilities, as measured by a pretest, the experimental and control classes were selected purposively. To maintain the internal validity of the study, this method is crucial because different results can be more easily attributed to the treatment provided (Risnawati et al., 2022).

THE EFFECTIVENESS OF PROBLEM BASED LEARNING MODEL IN IMPROVING STUDENTS' CRITICAL THINKING SKILLS AND LEARNING OUTCOMES

Surya Octavianus Simbolon et al

In this particular study, the variables examined consisted of two groups: the independent variable, which was the main focus of the study; the dependent variable, which included students' critical thinking skills and their learning outcomes, both of which were crucial for evaluating the study's effects. In this study, the concept of critical thinking skills was comprehensively understood and applied as students' ability to analyze, evaluate, and draw logical conclusions about a specific problem. This demonstrated a cognitive process essential for effective problem-solving. This ability was of primary concern because it is part of higher-order thinking skills, which are crucial for learning in the modern era (Yusuf Rambe et al., 2024). The research study was conducted through a tripartite framework consisting of three main stages: the preparation phase, the implementation phase, and the final phase. During the preparation phase, the researcher validated the research instruments essential for this study and systematically created a PBL-based learning tool. The administration of a pretest to the experimental and control groups marked the beginning of the implementation phase. This served as an important objective to assess the initial skills and abilities of the students involved in the study. Furthermore, a PBL learning environment was used in the experimental class. Its characteristics include problem-oriented activities, a comprehensive investigative process, student organization for collaborative learning, the development of tangible outcomes, and a robust evaluation framework. The control class, on the other hand, used a conventional learning approach, which focused significantly more on teacher instruction. Posttests, administered after the treatment phase, were administered to both groups. This is crucial for determining the extent to which the educational intervention improved students' abilities and competencies. This phase aligns with the features of PBL, which emphasizes active student involvement in systematic problem-solving.

For the purposes of this scientific investigation, data were carefully collected using a multifaceted approach that combined various methodologies, such as standardized tests, systematic observation, and comprehensive documentation of relevant information. Specifically, the test used in this study served as the primary tool for assessing students' critical thinking skills and their learning outcomes. The test was designed to perform these measurements using a pre-test and post-test format, and relied on robust critical thinking indicators, including essential skills such as the ability to analyze data. By implementing pre-tests and post-tests, the improvements in students' cognitive abilities resulting from the pedagogical interventions during the study could be clearly and thoroughly illustrated. Furthermore, observational methods were judiciously used to ensure the effective use of the Problem-Based Learning (PBL) model throughout the educational process, and comprehensive documentation was used to enhance and strengthen the collection of relevant research data. The collected data were analyzed in stages. First, a descriptive analysis was conducted to describe the data conditions. Next, normality and homogeneity tests were conducted to ensure that the data were normally distributed. Meanwhile, the normality test identified the similarity of variances between groups. Both tests are crucial for the application of parametric statistical analysis. Furthermore, to determine whether there were significant differences between the experimental and control groups, hypothesis testing was conducted using an independent t-test. This test was used because of its ability to statistically compare the means of the two groups. The aim was to determine whether the PBL model had a significant impact on students' critical thinking skills and their learning outcomes (Field, 2013). This study also used N-Gain calculations and effect sizes to determine the level of effectiveness and the magnitude of the PBL model's influence on the variables studied. This strengthened the analysis results. Previous research has shown that PBL significantly improves students' critical thinking skills, especially when used regularly. Overall, the methodology used in this study was carefully considered. The main objective of this methodological framework was to gain a comprehensive and diverse understanding of the extent to which the problem-based learning model helps students improve their critical thinking skills, their academic performance, and their overall learning outcomes. By using a systematic approach and appropriate analysis, the results of this study are expected to have potential.

RESULTS AND DISCUSSION

The results of this study are presented based on an analysis of critical thinking skills and student learning outcomes data obtained through pretests and posttests in the experimental and control classes. The data analyzed include average scores, ability gains, and significant differences between the two groups.

Table 1. Description of Research Sample

Group	Class	Number of Students	Information
Experiment	Class VIII-1	n= 36 People	Learning with PBL
Control	Class VIII-2	n= 36 People	Conventional learning

Based on the results of the descriptive analysis, students' critical thinking skills in the experimental class before treatment were in the low category, as indicated by the average pretest score still below the completion criteria.

THE EFFECTIVENESS OF PROBLEM BASED LEARNING MODEL IN IMPROVING STUDENTS' CRITICAL THINKING SKILLS AND LEARNING OUTCOMES

Surya Octavianus Simbolon et al

After being given treatment using the Problem-Based Learning (PBL) model, there was a significant increase in posttest scores. This increase indicates that students are beginning to be able to analyze problems, connect concepts to real-life situations, and draw more logical conclusions. This finding is in line with research results showing that the application of PBL can significantly improve students' critical thinking skills through active involvement in the learning process (Yusuf Rambe et al., 2024).

Meanwhile, in the control class using conventional learning, improvements in critical thinking skills did not show significant changes. Students tended to remain passive, relying more on receiving information than processing it independently. This suggests that teacher-centered learning is less effective in developing students' higher-order thinking skills, particularly in analysis and evaluation (Rauf et al., 2022).

Table 2. Average pretest, posttest, and N-Gain of thinking ability

Class	N	Pretest Average	Posttest Average	N-Gain	Category
Experiment (PBL)	30	54.20	82.47	0.62	Currently
Control (Conventional)	30	53.87	68.13	0.31	Currently

Table 3. Average pretest, posttest, and N-Gain Learning outcomes

Class	N	Pretest Average	Posttest Average	N-Gain	Category
Experiment (PBL)	30	56.10	84.33	0.64	Currently
Control (Conventional)	30	55.73	70.20	0.33	Currently

Table 4. Results of the independent sample t-test of critical thinking skills

Variables	Group	Mean	Elementary School	t	df	Sig. (2-tailed)	Information
Posttest of critical thinking skills	Experiment	82.47	7.84	5,214	58	0,000	Significant
	Control	68.13	8.92				

Table 5. Results of the independent sample t-test on learning outcomes

Variables	Group	Mean	Elementary School	t	df	Sig. (2-tailed)	Information
Posttest learning outcomes	Experiment	84.33	7.21	5,487	58	0,000	Significant
	Control	70.20	8.64				

Critical thinking skills

Based on Table 2, the average critical thinking ability of students in the experimental class before treatment was 54.20 and increased to 82.47 after the implementation of the Problem Based Learning model. The N-Gain value of 0.62 indicates that the increase in students' critical thinking abilities in the experimental class is in the moderate category. Meanwhile, the control class experienced an increase from 53.87 to 68.13 with an N-Gain of 0.31, which is also in the moderate category, but lower than the experimental class.

The results of the independent sample t-test in Table 4 show a significance value of $0.000 < 0.05$. This indicates a significant difference between students' critical thinking skills in the experimental and control classes after the treatment. Thus, the Problem-Based Learning model is more effective in improving students' critical thinking skills than conventional learning.

Learning outcomes

Based on Table 3, the average student learning outcomes in the experimental class increased from 56.10 in the pretest to 84.33 in the posttest. The N-Gain value of 0.64 indicates that the improvement in learning outcomes in the experimental class is in the moderate category. In the control class, the average learning outcomes increased from 55.73 to 70.20 with an N-Gain of 0.33, which is also in the moderate category, but still lower than the experimental class. The results of the independent sample t-test in Table 5 show a significance value of $0.000 < 0.05$. This finding indicates a significant difference between student learning outcomes in the experimental and control classes. Thus, the implementation of the Problem-Based Learning model has proven to be more effective in improving student learning outcomes than conventional learning.

THE EFFECTIVENESS OF PROBLEM BASED LEARNING MODEL IN IMPROVING STUDENTS' CRITICAL THINKING SKILLS AND LEARNING OUTCOMES

Surya Octavianus Simbolon et al

The data confirms that problem-based learning not only helps students think critically but also impacts conceptual understanding and academic achievement. Active student engagement in the learning process fosters more meaningful learning experiences, enabling material to be understood more deeply than simply rote memorization.

DISCUSSION

The analysis of student learning outcomes also showed a similar pattern. In the experimental class, the average posttest score increased significantly compared to the pretest. Students learning using the PBL model demonstrated a better understanding of concepts and were able to apply knowledge in different contexts. In contrast, in the control class, the improvement in learning outcomes was relatively lower, indicating that conventional learning was unable to provide meaningful learning experiences for students. Statistically, the results of the hypothesis test using an independent sample t-test showed a significant difference between the experimental and control classes, both in critical thinking skills and student learning outcomes. This indicates that the Problem-Based Learning model has a significant effect on both variables. These results support previous research showing that PBL can simultaneously improve critical thinking skills and student learning outcomes through a problem-based approach (Risnawati et al., 2022).

Furthermore, the N-Gain calculation results indicate that the improvement in critical thinking skills and learning outcomes in the experimental class was in the moderate to high category, while in the control class it was in the low category. This indicates that the effectiveness of the PBL model is higher compared to conventional learning. This finding supports research findings that state that PBL has a significant impact on improving learning outcomes because students are actively involved in the learning process and are able to construct knowledge independently (Hutagalung et al., 2023). Conceptually, the success of the PBL model in improving critical thinking skills and learning outcomes can be explained by learning characteristics that emphasize solving real-world problems. During the learning process, students are encouraged to identify problems, collect information, analyze data, and systematically develop solutions. These activities directly train critical thinking skills and improve conceptual understanding. Furthermore, interaction between students in group discussions also contributes to strengthening thinking and communication skills.

The findings of this study also align with international studies that state that PBL is effective in developing higher-order thinking skills, especially when learning is designed contextually and collaboratively (Yu & Zin, 2023). The integration of investigative and reflective activities in PBL enables students to build deeper and more meaningful understanding. However, the effectiveness of PBL is also influenced by several factors, such as teacher readiness in managing learning, time availability, and student characteristics. Suboptimal PBL implementation can result in learning not running according to expected goals. Therefore, careful planning and effective learning management are required for the PBL model to deliver optimal results.

The findings of this study demonstrate that the Problem-Based Learning model is effective in improving students' critical thinking skills and learning outcomes. This effectiveness can be understood from the main characteristic of PBL, which places real-world problems as the starting point of learning. When students are faced with contextual problems, they are encouraged to ask questions, explore information, analyze alternatives, and formulate solutions. This series of activities directly trains critical thinking skills and strengthens conceptual understanding. The results of this study align with various previous studies that confirm that PBL has a positive effect on critical thinking skills and student learning outcomes. Systematic reviews and meta-analyses indicate that PBL effectively improves reasoning quality, problem-solving abilities, and learning engagement, especially when teachers are able to design learning in a collaborative, reflective, and structured manner (Anggraeni et al., 2023; Li Lu et al., 2025; Yu & Zin, 2023). Research in the context of primary and secondary education also shows a significant increase in learning outcomes and critical thinking skills after the implementation of PBL (Hutagalung et al., 2023; Risnawati et al., 2022; Yusuf Rambe et al., 2024).

However, the success of PBL is largely determined by the teacher's readiness to manage the class, select authentic problems, manage time, and provide adequate scaffolding. If students are not accustomed to independent learning or the problems presented are too complex, the learning process can be less effective. Therefore, PBL implementation needs to be supported by careful planning, good learning tools, and continuous evaluation. Practically, the results of this study imply that teachers can utilize PBL as an alternative learning model for materials that require analysis, reasoning, and problem-solving. The application of this model is also relevant to the direction of 21st-century learning development, which emphasizes mastery of higher-order thinking skills.

CONCLUSION

Based on the research results and discussion, it can be concluded that the implementation of the Problem-Based Learning (PBL) model has proven effective in improving critical thinking skills and student learning outcomes. This improvement is evident in the significant differences between the experimental class using PBL and the control class using conventional learning. Students who participated in the PBL model demonstrated better abilities in analyzing problems, evaluating information, and drawing logical conclusions.

Furthermore, the PBL model also has a positive impact on student learning outcomes. Problem-centered learning encourages active student engagement, making it easier for them to understand concepts and apply them in real-world situations. This demonstrates that contextually and collaboratively designed learning can improve the quality of the learning process and outcomes.

Overall, the Problem-Based Learning model can be an effective learning alternative for developing higher-order thinking skills and improving student learning outcomes. Therefore, this model is recommended for use in the learning process, particularly in materials that require analytical and problem-solving skills. Future research is expected to examine the application of PBL in broader contexts and with broader variables to obtain more comprehensive results.

REFERENCES

- Anggraeni, DM, Prahani, BK, Suprpto, N., & Shofiyah, N. (2023). Systematic review of problem based learning research in fostering critical thinking skills. *Thinking Skills and Creativity*, 49(February), 101334. <https://doi.org/10.1016/j.tsc.2023.101334>
- Creswell, J. W. (2013). *John W. Creswell - Research Design_ Qualitative, Quantitative, and Mixed Method Approaches-SAGE Publications (2013).pdf*. <https://doi.org/10.1080/15424065.2022.2046231>
- Herman, H., Shara, AM, Silalahi, TF, Sherly, S., and Julyanthry, J. (2022). Teachers' Attitude Towards Minimum Competency Assessment at Sultan Agung Senior High School in Pematangsiantar, Indonesia. *Journal of Curriculum and Teaching*, 11(2), 01-14. DOI: <https://doi.org/10.5430/jct.v11n2p1>.
- Hestingtyas, W., Rizal, Y., Rahmawati, F., & History, A. (2021). *Economic Education Analysis Journal*. 10(1), 543–553. <https://doi.org/10.15294/eeaj.v10i3.50682>
- Hutagalung, MT, Siagian, AF, Saragih, ST, & Kritis, B. (2023). The Effect of Problem-Based Learning Model on Students' Critical Thinking Skills in the Energy Sources Subtheme. 438–444. <https://doi.org/10.47709/educendikia.v3i02.3058>
- Ida Bagus Amertha Putra Manuaba, Yi-No, & Chien-Chih Wu. (2022). The effectiveness of problem based learning in improving critical thinking, problem-solving and self-directed learning in first-year medical students: A meta-analysis. 1–12. <https://doi.org/10.1371/journal.pone.0277339>
- Li Lu, Siti Salina Mustakim, & Mohd Mokhtar Muhamad. (2025). A Meta-analysis of the Effectiveness of Problem-based Learning on Critical Thinking. 14(3), 789–804. <https://doi.org/10.12973/eu-jer.14.3.789>
- Panjaitan, MB, Siagian, AF, Purba, N., Herman, H., Sutikno, S., Sinaga, YK, and Sihombing, SD (2025) Fostering the Use of Talking Stick Learning Model on the Critical Thinking Ability in Science Learning. *Journal of Curriculum and Teaching*, 14(4), 14-25. DOI: <https://doi.org/10.5430/jct.v14n4p14>
- Purba, R., Herman, H., Purba, A., Hutauruk, AF, Silalahi, DE, Julyanthry, J., and Grace, E., (2022). Improving teachers' competence through the implementation of the 21st-century competencies in a post-COVID-19 pandemic. *Jurnal Masyarakat Mandiri*, 6(2), pp. 1486-1497. DOI: <https://doi.org/10.31764/jmm.v6i2.7340>
- Rauf, I., Arifin, IN, & Arif, RM (2022). The Effect of Problem-Based Learning Model on Students' Critical Thinking Skills. 13(No. 2), 163–183. <https://doi.org/10.37411/pedagogika.v13i2.1354>
- Risnawati, A., Nisa, K., & Oktaviyanti, I. (2022). The Effect of Problem Based Learning Model on Critical Thinking Skills of Fifth Grade Students on the Theme of Harmony in Society at SDN Wora.
- Wijayanto, PW, Priyatningsih, N., Herman, H., Sudadi, S., and Saputra, N. (2023). Implementation of Problem-Based Learning Model to Improve Early Childhood Abilities in Creative Thinking. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 7(1), 1017-1023. DOI: 10.31004/obsesi.v7i1.3909
- Yu, L., & Zin, Z. M. (2023). The critical thinking-oriented adaptations of problem-based learning models : a systematic review. <https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2023.1139987/full>
- Yusuf Rambe, Khaeruddin, & Ma'ruf. (2024). THE EFFECT OF THE PROBLEM-BASED LEARNING MODEL ON CRITICAL THINKING ABILITIES AND SCIENCE LEARNING OUTCOMES IN ELEMENTARY SCHOOL STUDENTS. 4(1), 341–355. <https://doi.org/10.51574/jrip.v4i1.1372>