International Journal of Educational Research Excellence (IJERE)
https://ejournal.ipinternasional.com/index.php/ijere

Volume 04, Issue 01, January-June 2025
e-ISSN:2830-7933
DOI: 10.55299/ijere.v4i1.1390

Enhancing Critical Thinking Skills Through Problem-Based Learning: A Classroom Intervention in Junior High School

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Article history: received May 01, 2025; revised May 26, 2025; accepted June 20, 2025

Abstract

This study explores the implementation of Problem-Based Learning (PBL) as an effective classroom intervention to enhance critical thinking skills among junior high school students in Indonesia. Using a qualitative approach with a pretest-posttest design, the intervention engaged ninth-grade students in collaborative problem-solving activities integrated into their regular curriculum. Data collected from standardized critical thinking assessments, observations, and student work showed significant improvement in students' critical thinking abilities after the PBL intervention. Specifically, students demonstrated enhanced analytical reasoning, argument analysis, and evidence-based evaluation skills, with average posttest scores rising from less critical to critical categories, reflecting improvements of over 20% across key indicators. Observations also revealed increased student engagement, collaboration, and confidence in articulating solutions. Despite challenges such as teacher preparedness, time constraints, and uneven participation, the study highlights the transformative potential of PBL in fostering higher-order thinking skills. Recommendations include targeted professional development, structured scaffolding, and leveraging technology to optimize implementation. These findings support PBL as a valuable pedagogical strategy to cultivate critical thinking, preparing junior high school students for complex problem-solving demands in the 21st century.

Keywords: *thinking, skills, problem-based, learning*

I. INTRODUCTION

In the 21st century, cultivating critical thinking skills in students has become an educational imperative. The ability to analyze, evaluate, and synthesize information is crucial for navigating an increasingly complex world. Traditional educational approaches in Indonesia often fall short in fostering these higher-order thinking skills, leading to a need for innovative pedagogical strategies that can promote deeper engagement and critical reasoning among students. This study addresses this gap by exploring the effectiveness of Problem-Based Learning (PBL) as a classroom intervention to enhance critical thinking skills in junior high school students (Xie, 2024).

Critical thinking is more than just memorizing facts; it involves the ability to approach problems systematically and make reasoned judgments. It encompasses a range of cognitive skills, including analysis, interpretation, evaluation, inference, explanation, and self-regulation. In the context of education, critical thinking enables students to question assumptions, consider different perspectives, and construct well-supported arguments. These skills are essential not only for academic success but also for informed decision-making in various aspects of life (Jumhur et al., 2024).

Despite its importance, critical thinking is not always explicitly taught or emphasized in Indonesian schools. Traditional teaching methods often prioritize rote learning and passive reception of information, which can hinder the development of analytical and problem-solving abilities. Teachers may face challenges in implementing effective strategies to promote critical thinking due to factors such as large class sizes, standardized curricula, and limited access to resources. As a result, many students may struggle to apply critical thinking skills in real-world contexts (Nugraha et al., 2024).

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Problem-Based Learning (PBL) offers a promising alternative to traditional instruction by placing students at the center of the learning process. In PBL, students work collaboratively to solve complex, open-ended problems that mirror real-world scenarios. This approach encourages active inquiry, reflection, and the integration of knowledge from different disciplines. By engaging with authentic problems, students develop a deeper understanding of the subject matter and enhance their ability to think critically.

The theoretical framework underlying PBL is rooted in constructivist learning theory, which posits that learners construct their own understanding through active engagement with the environment. In a PBL environment, students are not passive recipients of information but active participants who construct knowledge through exploration, experimentation, and collaboration. The teacher serves as a facilitator, guiding students through the problem-solving process and providing support as needed.

PBL has been well-established in higher education contexts and is gaining recognition as an effective approach to integrate knowledge and skills across disciplines in school-based education. Studies have shown that PBL can improve students' analytical, problem-solving, and communication skills by fostering active inquiry and reflection. It also supports the development of students as capable, self-directed learners, which is crucial for success in the 21st century (Y. Kurniawan, 2025).

Several studies in Indonesia have demonstrated the positive impact of PBL on students' critical thinking skills. For example, research has shown that the problem-based learning model supported by student worksheets is effective in increasing students' critical thinking skills. The implementation of PBL can increase students' active participation and collaboration skills, supported by the use of technology, and increases their problem-solving abilities and motivation. Moreover, ethnomathematics-based problem-based learning has been found to enhance creative thinking abilities and self-confidence among junior high school students.

However, the successful implementation of PBL requires careful planning and consideration of various factors. Teachers need to be trained in facilitating PBL activities and providing appropriate scaffolding for students. Access to resources, such as technology and real-world problems, is also essential. Additionally, it is important to address potential challenges such as uneven participation and time constraints.

This study aims to contribute to the growing body of research on PBL by examining its effectiveness as a classroom intervention to enhance critical thinking skills among junior high school students in Indonesia. Specifically, it seeks to answer the following research questions:

- What is the impact of PBL on students' critical thinking skills, as measured by standardized assessments?
- How does PBL influence students' engagement, collaboration, and problem-solving abilities in the classroom?
- What are the challenges and opportunities associated with implementing PBL in a junior high school setting in Indonesia?

To address these questions, a classroom intervention was conducted in a ninth-grade class in a state junior high school. The intervention involved integrating PBL sessions into the regular curriculum, with students working in groups to solve real-world problems relevant to their studies. Data were collected through pretest and posttest scores, observation checklists, and student work products.

The findings of this study have important implications for educators, policymakers, and researchers in Indonesia. By providing evidence of the effectiveness of PBL in enhancing critical thinking skills, it can inform decisions about curriculum development, teacher training, and resource allocation. It can also serve as a model for other schools and districts looking to implement PBL as a way to promote deeper learning and prepare students for the challenges of the 21st century.

II. METHODS

This study employed a classroom intervention approach using Problem-Based Learning (PBL) to enhance critical thinking skills among junior high school students. The research design, participants, instruments, procedures, and data analysis are described in detail below to provide a comprehensive understanding of the methodology.

Research Design

A quasi-experimental pretest-posttest single-group design was used to evaluate the effectiveness of the PBL intervention. This design involved measuring students' critical thinking skills before and after the implementation of PBL within their regular classroom setting. The pretest provided baseline data on students' critical thinking abilities, while the posttest assessed changes following the intervention. This approach allowed for the observation of skill development attributable to the PBL method without the need for a control group, which was not feasible in the school context.

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Participants

The participants were ninth-grade students from a public junior high school in Indonesia. A purposive sampling technique was used to select a class that was representative of the typical student population in terms of academic achievement and demographic characteristics. The class consisted of 30 students, aged between 14 and 15 years old, with mixed gender and diverse academic backgrounds. All students were informed about the study and consent was obtained from their parents or guardians.

Intervention Procedure

The intervention was implemented over a period of six weeks, integrated into the existing curriculum for science and social studies subjects. The PBL sessions were designed to engage students in solving real-world problems relevant to the topics being studied, thereby contextualizing learning and promoting critical thinking.

The PBL process followed these stages:

- Problem Presentation: At the start of each session, students were presented with a complex, open-ended problem related to the curriculum. Problems were designed to be authentic and relevant to students' daily lives, encouraging engagement and motivation.
- Problem Analysis and Hypothesis Generation: Students worked in small groups of 4-5 members to analyze the problem, identify what they knew and what they needed to learn, and formulate hypotheses or possible solutions.
- Self-Directed Learning: Groups identified learning resources, including textbooks, internet sources, and teacher guidance, to research and gather information necessary to address the problem.
- Solution Development: Students collaboratively developed solutions or responses to the problem based on their research and critical analysis.
- Presentation and Reflection: Each group presented their findings and solutions to the class, followed by a reflective discussion facilitated by the teacher to evaluate the reasoning process and the quality of solutions.

Throughout the intervention, the teacher acted as a facilitator, guiding inquiry, encouraging collaboration, and providing scaffolding when necessary to support students' critical thinking development.

Figure 1. Qualitative Method

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Data Analysis
Qualitative Analysis:
Observation notes, student worksheets, and group reports were analyzed thematically to identify patterns related to student engagement, collaboration, problem-solving strategies, and critical thinking processes. The qualitative data provided contextual insights into how PBL influenced students' learning behaviors and thinking skills.

Validity and Reliability
To ensure the validity of the critical thinking test, the instrument was reviewed by experts in educational assessment and piloted with a similar student group prior to the study. The observation checklist was developed based on established indicators of critical thinking and collaborative learning, and inter-rater reliability was calculated between observers, achieving a Cohen's kappa of 0.82, indicating strong agreement.

III. RESULTS AND DISCUSSION

A. *Research Result*
This section presents the findings from the classroom intervention aimed at enhancing critical thinking skills through Problem-Based Learning (PBL) among junior high school students. The results are organized into quantitative outcomes from pretest and posttest assessments, qualitative observations of classroom dynamics, and analysis of student work. The data demonstrate significant improvements in critical thinking skills, supported by statistical analysis and thematic insights.
The critical thinking skills of 30 ninth-grade students were assessed before and after the six-week PBL intervention using a standardized critical thinking test. The test measured key components of critical thinking, including analysis, evaluation, inference, and problem-solving

Table 1. Pretest and Posttest Critical Thinking Scores

Statistic	Pretest Score (Mean ± SD)	Posttest Score (Mean ± SD)	N-Gain Score	Wilcoxon Test (p-value)
Overall Critical Thinking	58.4 ± 7.2	74.9 ± 6.5	0.63	0.000
Analysis Subscale	55.1 ± 8.0	72.3 ± 7.1	0.62	0.000
Evaluation Subscale	57.8 ± 7.5	75.6 ± 6.8	0.65	0.000
Inference Subscale	59.3 ± 6.7	76.1 ± 6.3	0.62	0.000
Problem-Solving Subscale	60.0 ± 7.0	76.5 ± 6.0	0.61	0.000

Note: Scores are out of 100.

The mean overall critical thinking score increased from 58.4 in the pretest to 74.9 in the posttest, indicating a substantial improvement (N-Gain = 0.63), which falls into the "medium" to "high" gain category according to standard educational benchmarks. The Wilcoxon signed-rank test confirmed that the improvement was statistically significant ($p < 0.001$), rejecting the null hypothesis that there was no difference between pretest and posttest scores.
Subscale analyses revealed consistent gains across all critical thinking dimensions, with evaluation skills showing the highest improvement (N-Gain = 0.65). These results align with prior research indicating that PBL effectively enhances analytical and evaluative reasoning.
Observations during the PBL sessions highlighted several key themes related to student engagement, collaboration, and the development of critical thinking processes.

- Active Participation and Collaboration: Students actively engaged in group discussions, sharing diverse perspectives and negotiating solutions. Role assignments within groups helped balance participation, mitigating dominance by more vocal students.

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- Analytical Reasoning: Students demonstrated the ability to break down complex problems into manageable parts, identify relevant information, and apply disciplinary knowledge to propose logical solutions.
- Reflection and Metacognition: During presentations and teacher-facilitated discussions, students reflected on their problem-solving strategies, evaluating the strengths and weaknesses of their approaches.
- Challenges Noted: Some groups experienced uneven participation, with quieter students occasionally less involved. Time constraints limited the depth of inquiry in some sessions. Teachers reported initial difficulties in designing authentic problems and managing the inquiry process effectively.

B. *Analysis of Student Work*

Student worksheets and group reports provided further evidence of enhanced critical thinking. Essays and solution proposals showed well-structured arguments supported by evidence, creative problem-solving approaches, and clear justification of decisions.

For example, in a science lesson on environmental pollution, students analyzed causes and effects, proposed feasible solutions, and evaluated potential impacts. In mathematics, students applied budgeting concepts to real-life scenarios, justifying their financial decisions based on calculations and logical reasoning.

Table 2. Evidence of Improvement

Aspect	Evidence of Improvement	Supporting Data/Examples
Analytical Skills	Breaking down problems, identifying variables	Science pollution analysis, math budgeting tasks
Problem-Solving Abilities	Logical solution development, application of concepts	Group reports with justified financial plans
Collaboration and Communication	Balanced group discussions, diverse perspectives	Observation notes on role assignments and teamwork
Reflective Thinking	Evaluation of strategies, metacognitive awareness	Post-presentation discussions
Challenges	Uneven participation, time constraints, teacher readiness	Teacher interviews and observation notes

C. *Discussion*

The intervention demonstrated a statistically significant improvement in students' critical thinking skills across all measured dimensions—analysis, evaluation, inference, and problem-solving. The mean overall critical thinking score increased from 58.4 (pretest) to 74.9 (posttest), with an N-Gain of 0.63, indicating a medium to high level of improvement. Subscale analyses revealed consistent gains, with evaluation skills showing the highest improvement. Qualitative observations and analysis of student work further supported these findings, highlighting increased engagement, collaboration, and depth of reasoning (D. Kurniawan et al., 2024).

The results of this study are consistent with a growing body of research demonstrating the effectiveness of PBL in enhancing critical thinking skills among students at various educational levels. For instance, research by Oktosiyanti et al. (2025) and Arifin (2022) found that PBL fosters analytical reasoning, problem-solving, and collaborative communication in junior high school contexts. Similarly, studies in mathematics education using variants of PBL, such as the Independence Problem-Based Learning (IPBL) model, have reported significant improvements in students' critical thinking abilities, reinforcing the relevance of PBL for in-depth and effective learning (Abdullah et al., 2025) (Arifin, 2021).

The observed improvements align with theoretical models of PBL and constructivist learning, which emphasize active student engagement, inquiry, and reflection as drivers of higher-order thinking (Precellas & Napil, 2024). The five-phase PBL model—orienting problems, organizing research, assisting group investigations, developing and presenting work, and analyzing and evaluating the problem-solving process—was evident in classroom practice and proved effective in scaffolding students' critical thinking development .

The mechanisms by which PBL enhances critical thinking were evident in both quantitative and qualitative data. Students were required to analyze complex, real-world problems, generate hypotheses, conduct self-directed research, and

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collaboratively develop and present solutions (Uebel et al., 2024). This process necessitated the application of critical thinking sub-skills, including:

- Analysis: Breaking down problems and identifying key variables, as seen in science and mathematics tasks.
- Evaluation: Judging the quality and feasibility of proposed solutions, supported by evidence and logical reasoning.
- Inference: Drawing conclusions from data and information gathered during group research.
- Problem-Solving: Applying disciplinary knowledge to develop creative and practical solutions.

The collaborative nature of PBL further facilitated the exchange of diverse perspectives, fostering open-mindedness and enhancing students' ability to justify and defend their ideas in group settings. Reflective activities, such as post-presentation discussions, encouraged metacognitive awareness and self-evaluation, which are essential components of critical thinking.

The findings of this study are supported by international research on the impact of PBL on critical thinking. For example, a study by Risqillah et al., (2025) found statistically significant improvements in all sub-skills of critical thinking among students exposed to PBL, with the experimental group outperforming the control group in posttest assessments (Risqillah et al., 2025). These results underscore the generalizability of PBL's benefits across cultural and educational contexts.

Moreover, the integration of technology and digital resources, as recommended in recent studies, can further enhance the effectiveness of PBL by providing access to diverse information sources and supporting collaborative inquiry. However, the core principles of active learning, inquiry, and reflection remain central to PBL's success.

The demonstrated effectiveness of PBL in enhancing critical thinking skills has important implications for curriculum development and instructional practice in Indonesian junior high schools. Incorporating PBL into the curriculum can shift the focus from rote memorization to the development of higher-order thinking skills, better preparing students for the demands of the 21st century. Teachers should be encouraged and supported to adopt PBL methodologies, with appropriate training and resources provided to facilitate implementation (Dewi et al., 2025).

Successful implementation of PBL is contingent upon teacher preparedness and competence in facilitating inquiry-based learning (Manizabayo & Kachchhap, 2025) (Nghiem et al., 2025). Professional development programs should focus on building teachers' skills in designing authentic problems, managing group dynamics, and scaffolding students' critical thinking processes. Ongoing support and collaboration among teachers can foster a community of practice and promote the continuous refinement of PBL strategies (Musharrat & Chowdhury, 2020).

PBL has the potential to increase student engagement and motivation by connecting learning to real-world issues and empowering students to take ownership of their learning. However, attention must be paid to ensuring equitable participation among all students, particularly those who may be less confident or vocal in group settings. Structured role assignments, clear expectations, and supportive classroom environments can help address these challenges and promote inclusive learning experiences.

IV. CONCLUSIONS

the findings of this classroom intervention confirm that Problem-Based Learning is a powerful pedagogical strategy for enhancing critical thinking skills among junior high school students. The statistically significant improvements in critical thinking test scores, supported by qualitative evidence of increased engagement, collaboration, and reflective thinking, underscore the transformative potential of PBL in secondary education. The alignment of these results with existing literature and theoretical frameworks provides strong justification for the broader adoption of PBL in Indonesian schools. However, realizing the full benefits of PBL requires sustained commitment to teacher development, resource provision, and curriculum innovation. By fostering analytical reasoning, problem-solving, and collaborative learning, PBL prepares students not only for academic success but also for the complex challenges of the modern world. The insights gained from this study can inform policy and practice, guiding efforts to cultivate a new generation of critical thinkers equipped to thrive in an ever-changing society.

ACKNOWLEDGEMENTS

Author thanks to all people and institution in most cases, sponsor and financial support acknowledgments.

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