



# Efforts to Improve Students' Logical Thinking Skills by Applying the Problem-Based Learning Model to Mathematics Learning at MIN Payaseunara

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## ABSTRACT

This classroom action research aimed to improve students' logical thinking skills in mathematics learning through the implementation of the Problem-Based Learning (PBL) model at MIN Payaseunara. The study was conducted in two cycles consisting of planning, action, observation, and reflection stages. The participants were 28 fifth-grade students. Data were collected using logical thinking skill tests, observation sheets of teacher and student activities, and field notes. The indicators of logical thinking measured included reasoning ability, problem analysis, systematic solution planning, and conclusion drawing. The findings showed a significant improvement in students' logical thinking skills after the implementation of PBL. In the pre-cycle stage, the average score of students' logical thinking ability was 59.21, with only 39.29% of students achieving the minimum mastery criterion. After the implementation of PBL in Cycle I, the average score increased to 70.46 and learning mastery improved to 67.86%. Furthermore, Cycle II demonstrated a more substantial improvement, with the average score reaching 82.14 and mastery learning increasing to 89.29%. Observation results also indicated that teacher activity improved from 72.50% in Cycle I to 90.00% in Cycle II, while student learning activity increased from 68.75% to 88.50%. These results confirm that the PBL model effectively enhances students' logical thinking skills by encouraging active engagement, collaborative problem-solving, and structured reasoning processes. Therefore, Problem-Based Learning can be recommended as an effective instructional strategy to improve logical thinking competence in elementary mathematics education.

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## Introduction

Logical thinking skills are widely recognized as a fundamental competence in mathematics learning, particularly at the elementary education level where students begin to develop structured reasoning patterns and analytical abilities. Logical thinking enables learners to interpret mathematical relationships, understand concepts

systematically, and draw valid conclusions based on evidence and reasoning. In the context of 21st-century education, logical thinking is not only essential for mastering mathematics but also for building broader problem-solving and decision-making skills that are required in academic and real-life situations (OECD, 2019). Therefore, strengthening students' logical thinking ability has become a major priority in mathematics education reform.

Mathematics is frequently regarded as a subject that requires more than procedural skills. It demands conceptual understanding, critical reasoning, and the ability to connect mathematical knowledge with contextual situations (NCTM, 2000). However, many elementary students struggle to achieve strong logical reasoning because mathematics is often taught through conventional teacher-centered approaches that emphasize memorization and routine exercises rather than meaningful problem analysis (Boaler, 2016). Such practices may limit students' opportunities to develop reasoning strategies, explain their thinking, and evaluate alternative solutions in a structured manner.

The development of logical thinking in mathematics learning is closely related to cognitive development theory. Piaget argued that children gradually develop logical reasoning through stages of cognitive maturity, especially as they transition from concrete operational thinking to more formal reasoning processes (Piaget, 1972). At the elementary level, students require learning experiences that support reasoning through manipulation of real situations, exploration, and guided inquiry. When instruction is dominated by direct explanation and repetition, students may remain passive and rely heavily on teacher guidance rather than building their own logical frameworks for understanding mathematical concepts (Slavin, 2018).

Logical thinking is also strongly linked with mathematical literacy, which refers to the ability to apply mathematical reasoning to interpret and solve problems in diverse contexts (Stacey, 2011). Mathematical literacy is an important global benchmark, as reflected in international assessments such as PISA. The PISA results consistently show that students' reasoning and problem-solving abilities remain a challenge in many countries, particularly in tasks requiring multi-step logical analysis and interpretation of real-world situations (OECD, 2019). This suggests that mathematics learning must shift toward approaches that explicitly cultivate reasoning and logical thinking.

In Indonesia, mathematics learning at the primary level continues to face challenges in fostering students' reasoning competence. Studies have reported that many students demonstrate limited ability to explain mathematical arguments, connect concepts, and provide justification for their answers (Suryadi, 2019). This issue is frequently associated with instructional practices that prioritize final answers rather than reasoning processes. Consequently, students may be able to solve routine

questions but fail to manage contextual or non-routine problems that require deeper analysis and structured thinking (Widodo & Kadarwati, 2013).

The demand for improved logical thinking in elementary mathematics education is aligned with the broader educational goals of the Indonesian curriculum. The Merdeka Curriculum emphasizes student-centered learning, critical thinking, and problem-solving competence as key learning outcomes (Ministry of Education, Culture, Research, and Technology of Indonesia, 2022). This curriculum shift requires teachers to adopt learning models that provide opportunities for students to engage in inquiry, reasoning, and reflective thinking. However, implementing such approaches in classroom practice remains a challenge, particularly in schools where traditional instructional culture is still dominant.

One instructional model that is widely recommended to foster reasoning and logical thinking is Problem-Based Learning (PBL). PBL is an approach that begins with real or contextual problems and encourages students to explore, analyze, and propose solutions collaboratively (Hmelo-Silver, 2004). Through problem-solving activities, students are required to construct meaning, identify relevant information, and apply logical reasoning in order to reach conclusions. As a result, PBL is often considered an effective strategy to develop higher-order thinking skills, including logical thinking and critical reasoning (Savery, 2015).

Problem-Based Learning is grounded in constructivist learning theory, which emphasizes that learners actively build knowledge through experiences and reflection rather than receiving information passively (Fosnot, 2013). In PBL, students engage with meaningful tasks that require investigation, hypothesis formation, evaluation of alternative strategies, and justification of decisions. These processes are strongly aligned with the characteristics of logical thinking in mathematics learning. By requiring students to articulate reasoning, PBL supports deeper conceptual understanding and reduces dependence on rote memorization (Jonassen, 2011).

Several empirical studies have shown that PBL contributes positively to mathematics achievement and reasoning skills. Research indicates that students taught through PBL demonstrate improved conceptual understanding, better ability to analyze problems, and stronger reasoning competence compared to those taught through conventional methods (Yew & Goh, 2016). Moreover, PBL has been found to improve students' motivation and learning engagement because the learning process is built around authentic and meaningful problems (Hung, 2011). Engagement is a key factor in logical thinking development, as students are more likely to reason deeply when they are actively involved in problem exploration.

In addition to improving academic outcomes, PBL has been identified as a powerful model for promoting collaborative learning. Collaboration encourages

students to exchange ideas, evaluate different perspectives, and justify reasoning in front of peers, which enhances logical thinking and argumentation skills (Johnson & Johnson, 2009). In mathematics learning, discussion and reasoning exchanges allow students to identify misconceptions, refine problem-solving strategies, and develop systematic approaches to drawing conclusions (Stein et al., 2008). Thus, PBL supports not only individual reasoning but also social construction of knowledge.

Despite its potential, the application of PBL in elementary mathematics classrooms is not always effective without appropriate teacher facilitation. Teachers play a central role in guiding inquiry, providing scaffolding, and ensuring that students remain focused on logical reasoning rather than guessing answers (Hmelo-Silver, Duncan, & Chinn, 2007). Effective facilitation involves asking probing questions, encouraging justification, and supporting students in organizing their reasoning processes. Therefore, professional competence and instructional planning become crucial for successful implementation of PBL.

Classroom Action Research (CAR) is a suitable research design to address such instructional challenges because it provides a reflective framework for improving teaching practices through iterative cycles of planning, action, observation, and reflection (Kemmis & McTaggart, 2014). CAR allows teachers and researchers to identify classroom problems, implement interventions, and evaluate outcomes systematically. In the context of mathematics learning, CAR is often used to test the effectiveness of instructional models such as PBL in improving specific student competencies, including logical thinking and reasoning skills (Burns, 2010).

Previous studies in Indonesia have demonstrated that CAR-based implementation of PBL can improve students' learning outcomes and reasoning abilities. For example, research has shown that PBL increases students' problem-solving skills and learning motivation in elementary mathematics contexts (Rahmawati & Suryanto, 2020). However, findings also indicate that improvement is often gradual and requires continuous refinement of learning strategies, classroom management, and scaffolding methods across cycles. This suggests that CAR provides a practical approach to optimizing PBL implementation in real classroom conditions.

The urgency of improving logical thinking skills becomes more evident when considering that elementary students often develop misconceptions in mathematics due to limited reasoning opportunities. Misconceptions may occur when students rely on memorized formulas without understanding underlying principles (Van de Walle, Karp, & Bay-Williams, 2019). When students encounter new or complex problems, they may struggle because their thinking is not grounded in logical structures. Therefore, instructional interventions must emphasize reasoning and conceptual understanding rather than procedural repetition.

Furthermore, logical thinking is essential in developing students' ability to solve mathematical problems systematically. Problem-solving involves identifying given information, formulating strategies, implementing procedures, and evaluating results (Polya, 1957). These steps require logical reasoning and reflective thinking. In many classrooms, students are not trained to follow systematic reasoning steps; instead, they often seek quick answers. PBL provides a learning environment where students must engage in systematic thinking processes, which is consistent with Polya's problem-solving framework.

Mathematics learning in Islamic elementary schools such as MIN (Madrasah Ibtidaiyah Negeri) also requires contextual instructional approaches that align with students' characteristics and learning needs. Madrasah students often learn within a curriculum that integrates general education and Islamic values, which provides opportunities for holistic development (Azra, 2017). Therefore, implementing PBL in madrasah contexts is relevant because PBL emphasizes meaningful learning experiences that can be integrated with real-life values and contexts. This integration may strengthen students' motivation and help them perceive mathematics as a useful tool for everyday reasoning.

However, the implementation of innovative learning models in madrasah contexts faces challenges such as limited learning resources, varied teacher readiness, and students' diverse learning abilities. Studies suggest that many teachers still struggle to design contextual problems and manage student-centered activities effectively (Darling-Hammond, 2017). These challenges may hinder the development of logical thinking if instructional practices remain dominated by conventional methods. Consequently, research on effective instructional interventions in madrasah settings remains highly relevant.

At MIN Payaseunara, preliminary observations indicated that students' logical thinking skills in mathematics learning were relatively low. Many students experienced difficulty in analyzing word problems, organizing solution steps, and drawing correct conclusions. Students also tended to depend heavily on teacher explanations and showed limited confidence in expressing reasoning. This condition reflects a broader issue in mathematics instruction where students are often not trained to explore and justify their thinking processes (Boaler, 2016). Such findings highlight the need for an instructional improvement strategy that supports active reasoning development.

Based on these conditions, Problem-Based Learning was selected as an instructional intervention to improve students' logical thinking skills. PBL was considered appropriate because it provides students with opportunities to analyze contextual problems, explore solutions collaboratively, and develop systematic reasoning strategies. The learning process emphasizes student engagement, discussion, and

reflection, which are essential components in developing logical thinking competence (Savery, 2015). Moreover, PBL aligns with contemporary curriculum expectations that prioritize higher-order thinking and meaningful learning experiences.

The novelty of this study lies in its focus on improving logical thinking skills through PBL implementation in a madrasah elementary school context using a structured classroom action research design. While previous research has explored PBL in general elementary schools, studies focusing specifically on MIN environments remain limited, particularly in relation to logical thinking indicators such as reasoning, analysis, systematic planning, and conclusion drawing. Therefore, this study contributes empirical evidence to support the effectiveness of PBL in enhancing logical reasoning in mathematics learning within Islamic primary education settings.

This study is also significant because it provides practical insights for teachers regarding how to implement PBL effectively through iterative cycles of reflection and improvement. The CAR design enables the identification of instructional weaknesses and the refinement of learning strategies across cycles, ensuring that PBL is not merely applied as a concept but optimized as a classroom practice. Such practical contributions are essential for improving instructional quality and supporting sustainable learning improvement (Kemmis & McTaggart, 2014).

Accordingly, the main research objective of this study was to improve students' logical thinking skills in mathematics learning through the application of the Problem-Based Learning model at MIN Payaseunara. Specifically, the study aimed to examine the improvement of students' reasoning competence, problem analysis ability, systematic problem-solving strategies, and conclusion drawing skills through the implementation of PBL across two action cycles. The research also sought to analyze changes in teacher and student learning activities as supporting indicators of successful instructional improvement.

Improving logical thinking skills is a crucial challenge in elementary mathematics education, particularly in contexts where conventional instruction still dominates learning practices. Problem-Based Learning offers a promising approach because it encourages active reasoning, collaborative inquiry, and systematic problem-solving processes. Through the classroom action research framework, this study attempts to provide evidence-based findings regarding the effectiveness of PBL in improving logical thinking skills among students at MIN Payaseunara, thereby contributing to both theoretical understanding and practical implementation in mathematics education.

## **Methods**

This study employed a Classroom Action Research (CAR) design aimed at improving students' logical thinking skills through the implementation of the Problem-Based

Learning (PBL) model in mathematics instruction. Classroom action research was selected because it provides a systematic framework for improving learning practices through iterative cycles of planning, action, observation, and reflection, allowing teachers to evaluate and refine instructional strategies based on real classroom conditions (Kemmis & McTaggart, 2014). The research was conducted collaboratively between the classroom teacher and the researcher to ensure both practical relevance and methodological rigor.

The research was carried out at MIN Payaseunara during the second semester of the 2025/2026 academic year. The participants consisted of 28 fifth-grade students, comprising 14 male and 14 female students. The selection of participants was based on the researcher's preliminary observation indicating that students' logical thinking performance in mathematics learning was still below the expected mastery level. The classroom teacher also served as the main implementer of the learning intervention, while the researcher acted as an observer and facilitator throughout the research process.

The study was conducted in two action cycles, with each cycle consisting of four stages: planning, implementation of action, observation, and reflection. Each cycle was implemented in two meetings, and each meeting lasted approximately  $2 \times 35$  minutes according to the standard lesson duration in elementary school. The first cycle focused on introducing and implementing the PBL model in mathematics learning activities, while the second cycle emphasized improvement and refinement based on the evaluation of Cycle I outcomes. The CAR procedure followed the spiral model proposed by Kemmis and McTaggart, where each cycle was designed as a continuous process of improvement (Kemmis & McTaggart, 2014).

In the planning stage, the researcher and the classroom teacher collaboratively prepared learning tools and research instruments. These included lesson plans aligned with the PBL stages, student worksheets containing contextual mathematical problems, logical thinking assessment tests, observation sheets for teacher and student activities, and documentation guidelines. The mathematical topics selected for intervention were adjusted to the Grade V curriculum and focused on problem-solving tasks requiring logical reasoning, analysis, and structured solution procedures.

The action stage involved implementing Problem-Based Learning in classroom instruction. The PBL procedures applied in this study were adapted from established learning frameworks, emphasizing student-centered inquiry and collaborative problem-solving (Savery, 2015). The learning process began with presenting contextual problems related to students' daily experiences. Students were then encouraged to identify the problem, formulate hypotheses, gather relevant information, discuss alternative strategies in groups, and propose solutions. During the learning process, the teacher

acted as a facilitator by providing guiding questions and scaffolding to help students organize their reasoning processes, in line with constructivist instructional principles (Hmelo-Silver, 2004). At the end of each meeting, students were asked to present their solutions and reflect on the reasoning process used.

The observation stage was conducted simultaneously with the implementation of each action. Observations focused on measuring the level of teacher instructional performance and student learning activity during PBL implementation. Teacher activity was observed based on indicators such as lesson preparation, clarity of problem presentation, facilitation of group discussion, use of questioning strategies, and classroom management. Student activity was assessed based on participation in group discussion, engagement in problem analysis, contribution to solution planning, ability to communicate reasoning, and cooperation within learning groups. The observation process used structured observation sheets and field notes to ensure systematic and comprehensive documentation.

The reflection stage was conducted at the end of each cycle to evaluate the learning outcomes and identify weaknesses in the implementation process. Reflection was based on student test results, observation findings, and documentation of classroom learning activities. The results of Cycle I reflection were used as the basis for revising lesson plans, improving scaffolding techniques, refining learning materials, and enhancing group management strategies in Cycle II. This reflective process ensured that the implementation of PBL became progressively more effective in improving students' logical thinking competence.

Data collection in this study employed both quantitative and qualitative techniques. Quantitative data were obtained from logical thinking skill tests administered at the end of each cycle. The test was designed to measure students' logical reasoning based on four indicators: problem analysis ability, systematic planning of solutions, accuracy of reasoning procedures, and conclusion drawing. The test consisted of essay-based contextual mathematical problems requiring students to provide written explanations of their reasoning steps. Qualitative data were obtained from observation sheets, field notes, and documentation such as student work results and classroom learning records.

The main research instruments included logical thinking tests and observation sheets. The logical thinking test instrument was validated through expert judgment involving two mathematics education lecturers and one experienced elementary school teacher. The validation process focused on content relevance, clarity of problem statements, and alignment with logical thinking indicators. Observation sheets were also reviewed to ensure that the indicators accurately represented teacher and student performance during PBL learning activities. To strengthen the credibility of qualitative

data, triangulation was applied by comparing findings from observation sheets, field notes, and documentation (Creswell & Creswell, 2018).

Data analysis was conducted using descriptive quantitative and qualitative approaches. Quantitative data from the logical thinking tests were analyzed by calculating students' mean scores and mastery learning percentages in each cycle. The mastery criterion in this study referred to the Minimum Mastery Criterion (KKM) applied in the school, which was set at 75. The percentage of mastery learning was calculated by dividing the number of students achieving scores equal to or above the KKM by the total number of students, multiplied by 100%. The improvement of students' logical thinking skills was determined by comparing the pre-cycle, Cycle I, and Cycle II test results.

Qualitative data from observation sheets and field notes were analyzed through data reduction, data display, and conclusion drawing. The analysis process aimed to describe patterns of student engagement, group collaboration, and teacher facilitation strategies during PBL implementation. The qualitative findings were used to support and interpret the quantitative results, providing a comprehensive understanding of how the PBL model influenced students' logical thinking development.

The success indicators of this study were determined based on both learning outcomes and learning process criteria. The intervention was considered successful if at least 85% of students achieved the minimum mastery criterion and if student activity during learning reached a minimum category of "active" based on observation results. Additionally, improvement in teacher performance was considered an important supporting indicator to ensure the sustainability of effective PBL implementation. These criteria were used as benchmarks to evaluate the effectiveness of the intervention across the two action cycles.

Ethical considerations were addressed throughout the research process. Permission to conduct the research was obtained from the school principal and classroom teacher. Students' participation was conducted as part of regular classroom learning activities without disrupting the learning process. The confidentiality of student data was maintained by reporting results in aggregate form, ensuring that no individual student identities were disclosed.

This methodological approach provided a systematic and reflective framework for evaluating the effectiveness of Problem-Based Learning in improving students' logical thinking skills in mathematics learning at MIN Payaseunara. The combination of quantitative learning outcome measurement and qualitative process analysis strengthened the validity of findings and ensured that the research results were grounded in authentic classroom practice.

## Result

This classroom action research focused on improving students' logical thinking skills in mathematics learning through the implementation of the Problem-Based Learning (PBL) model at MIN Payaseunara. The results were obtained from logical thinking tests administered during the pre-cycle stage, Cycle I, and Cycle II. In addition, the learning process was evaluated through observation sheets assessing teacher activity and student learning activity during the implementation of PBL.

The logical thinking test measured students' performance based on four main indicators, namely problem analysis ability, systematic planning of solutions, accuracy of reasoning procedures, and conclusion drawing. The quantitative results indicate that the PBL intervention produced a consistent improvement in students' logical thinking skills from one cycle to the next.

The improvement can be clearly seen in the comparison of students' mean scores and mastery learning percentages. Before the intervention was implemented, students' logical thinking ability was still categorized as low. Most students had difficulty analyzing contextual problems, identifying relevant mathematical information, and organizing solution steps logically. However, after PBL was applied, students gradually showed stronger reasoning performance and more systematic thinking patterns in solving mathematical problems. The overall improvement in students' logical thinking test scores is presented in Table 1.

**Table 1.** Students' Logical Thinking Skills Improvement (Pre-Cycle, Cycle I, and Cycle II)

Stage	Mean Score	Students Achieving KKM ( $\geq 75$ )	Mastery Percentage
Pre-Cycle	59.21	11 out of 28	39.29%
Cycle I	70.46	19 out of 28	67.86%
Cycle II	82.14	25 out of 28	89.29%

The data in Table 1 demonstrate a significant improvement in students' logical thinking skills after the implementation of the PBL model. In the pre-cycle stage, the mean score was only 59.21, and the percentage of students achieving mastery learning was 39.29%. This indicates that more than half of the students were still unable to meet the minimum mastery criterion (KKM), which was set at 75.

After the first cycle of PBL implementation, students' mean score increased to 70.46, representing an improvement of 11.25 points compared to the pre-cycle stage. Additionally, the mastery learning percentage increased to 67.86%, meaning that 19 out of 28 students successfully reached the KKM. Although the improvement was

considerable, the mastery percentage had not yet met the success indicator of the study, which required at least 85% of students to achieve mastery learning.

In Cycle II, the improvement became more significant. The mean score increased further to 82.14, showing an increase of 11.68 points compared to Cycle I and 22.93 points compared to the pre-cycle stage. Furthermore, the mastery learning percentage reached 89.29%, with 25 out of 28 students meeting the KKM. This result exceeded the success criterion, indicating that the PBL intervention was effective in improving students' logical thinking skills.

In addition to measuring learning outcomes, the study also evaluated the learning process through observation of teacher and student activities. Observation results indicated that both teacher instructional performance and student engagement improved from Cycle I to Cycle II. The improvement in teacher activity is presented in Table 2.

**Table 2.** Teacher Activity Observation Results

Cycle	Teacher Activity Percentage	Category
Cycle I	72.50%	Good
Cycle II	90.00%	Very Good

The results in Table 2 indicate that teacher activity increased significantly. In Cycle I, the teacher activity percentage was 72.50%, categorized as good. During this cycle, the teacher began applying PBL stages by presenting contextual problems, organizing group discussions, and guiding students' reasoning. However, several weaknesses were observed, such as limited time management, insufficient probing questions, and uneven facilitation across groups.

In Cycle II, teacher activity improved to 90.00%, categorized as very good. The teacher demonstrated stronger classroom management, provided clearer problem orientation, and facilitated deeper student inquiry through guiding questions. The teacher also improved the scaffolding process by encouraging students to justify their reasoning and reflect on their solution strategies. Student learning activity also improved across cycles. The observation results are presented in Table 3.

**Table 3.** Student Activity Observation Results

<b>Cycle</b>	<b>Student Activity Percentage</b>	<b>Category</b>
Cycle I	68.75%	Active
Cycle II	88.50%	Very Active

Table 3 indicates that student learning activity increased from 68.75% in Cycle I to 88.50% in Cycle II. In Cycle I, students began to show active participation in group discussion, but some students remained passive and depended on higher-performing peers. Several students also hesitated to express their opinions or reasoning during group presentations.

In Cycle II, student engagement increased substantially. Most students actively participated in analyzing problems, proposing solution strategies, and communicating their reasoning. Students were more confident in explaining mathematical steps and were able to evaluate alternative strategies during group discussion. This suggests that PBL encouraged students to become more involved in the learning process and promoted collaborative reasoning.

The findings demonstrate that the implementation of the Problem-Based Learning model not only improved students' logical thinking outcomes but also enhanced the learning process by increasing teacher instructional quality and student engagement. The results confirm that the PBL model contributed to more meaningful mathematics learning experiences, enabling students to develop systematic reasoning skills and improve mastery learning achievement.

## Discussion

The results of this classroom action research demonstrate that the Problem-Based Learning model significantly improved students' logical thinking skills in mathematics learning at MIN Payaseunara. The improvement in mean scores and mastery learning percentages across cycles confirms that PBL was effective in enhancing students' reasoning ability, problem analysis skills, systematic solution planning, and conclusion drawing competence. This finding aligns with the theoretical foundation of PBL, which emphasizes student-centered inquiry and active knowledge construction through meaningful problem-solving activities (Savery, 2015).

The low results in the pre-cycle stage reflect a common problem in elementary mathematics education, where students tend to rely heavily on procedural memorization rather than logical reasoning. In conventional learning settings, students often focus on obtaining correct answers without understanding the underlying

concepts or developing structured reasoning strategies. As noted by Boaler (2016), mathematics learning that emphasizes repetitive exercises may limit students' cognitive engagement and reduce opportunities for higher-order reasoning development. The pre-cycle mean score of 59.21 and mastery percentage of only 39.29% indicate that most students had not yet developed sufficient logical thinking competence to meet the expected standard.

After the implementation of PBL in Cycle I, students' mean score increased to 70.46 and mastery learning improved to 67.86%. This improvement indicates that PBL began to shift students' learning behavior from passive reception toward active engagement in reasoning processes. The PBL environment required students to analyze contextual problems, identify relevant information, and explore solution strategies collaboratively. According to Hmelo-Silver (2004), the main strength of PBL lies in its ability to promote deeper cognitive processing by positioning students as active problem solvers rather than passive learners. This explains why students demonstrated noticeable progress in Cycle I, even though the success indicator had not yet been fully achieved.

The results also indicate that Cycle I was an adaptation phase for both students and the teacher. Students who were accustomed to teacher-centered instruction needed time to adjust to collaborative inquiry and open-ended problem-solving. Several students still showed hesitation in expressing ideas, and some depended on dominant peers during group work. Such conditions are consistent with research suggesting that students initially face challenges in PBL settings because they must develop self-directed learning habits and communication skills (Hung, 2011). Therefore, the moderate improvement in Cycle I can be interpreted as the beginning of students' transition toward more independent and logical reasoning patterns.

A more substantial improvement occurred in Cycle II, where the mean score increased to 82.14 and mastery learning reached 89.29%. This result exceeded the success criterion of the study and indicates that PBL became more effective after refinement and reflection from Cycle I. The reflection process enabled the teacher to improve scaffolding strategies, provide more structured guidance, and manage learning time more efficiently. This finding supports the view that teacher facilitation is essential in maximizing PBL effectiveness, particularly in elementary classrooms where students still require guidance to structure their reasoning (Hmelo-Silver et al., 2007).

The increased mastery learning percentage in Cycle II also suggests that PBL helped students develop systematic thinking in solving mathematical problems. Through repeated exposure to contextual problems, students became more skilled in identifying problem elements, selecting appropriate strategies, and justifying their answers logically. This aligns with Polya's (1957) theory of mathematical problem-solving, which emphasizes the importance of understanding the problem, planning a solution,

implementing the plan, and reviewing the result. PBL encourages students to follow these reasoning steps naturally through group discussion and inquiry-based exploration.

The improvement in logical thinking skills was also closely linked to the increase in student learning activity. Student activity increased from 68.75% in Cycle I to 88.50% in Cycle II. This indicates that students became more engaged, confident, and active in collaborative problem-solving. According to Johnson and Johnson (2009), collaborative learning promotes reasoning development because students must articulate arguments, listen to alternative perspectives, and negotiate meaning through discussion. This process strengthens logical thinking because students learn to evaluate ideas critically and justify their reasoning.

Furthermore, the improvement in student engagement demonstrates that PBL contributed to increased motivation and meaningful learning experiences. Contextual problems presented in PBL encouraged students to see mathematics as relevant to real-life situations, which enhanced their interest and cognitive involvement. This finding supports the argument that authentic learning tasks increase students' intrinsic motivation and promote deeper understanding (Jonassen, 2011). Students are more likely to engage in logical reasoning when learning tasks are meaningful and connected to their daily experiences.

Teacher activity also improved significantly, from 72.50% in Cycle I to 90.00% in Cycle II. This indicates that the teacher became more effective in facilitating PBL stages, guiding inquiry, and supporting student reasoning. Effective teacher facilitation is crucial in ensuring that PBL does not become merely group work without cognitive depth. Teachers must provide guiding questions, monitor group discussions, and encourage students to justify their reasoning processes (Savery, 2015). The increase in teacher activity suggests that the teacher was able to refine instructional techniques after reflecting on Cycle I outcomes.

The success of PBL in improving logical thinking skills can also be explained through constructivist learning theory. Constructivism emphasizes that knowledge is actively constructed through experiences and social interaction rather than passively received (Fosnot, 2013). In this study, students constructed mathematical understanding through collaborative exploration of problems, discussion of solution strategies, and reflection on reasoning processes. This learning environment provided opportunities for students to develop logical frameworks and internalize mathematical concepts more deeply.

The findings of this study are consistent with previous research indicating that PBL enhances reasoning skills and mathematics achievement. Studies have shown that PBL improves students' critical thinking and problem-solving abilities by encouraging them to

engage in inquiry and reflection (Yew & Goh, 2016). Similarly, research by Savery (2015) emphasizes that PBL fosters higher-order thinking by requiring students to analyze problems, integrate knowledge, and propose solutions systematically. Therefore, the results of this study contribute further empirical evidence that PBL is an effective instructional model for improving logical thinking skills in elementary mathematics education.

The madrasah context of this study also provides an important contribution to mathematics education research. Madrasah students learn within a curriculum that integrates general education and Islamic values, which may influence learning motivation and classroom culture. Implementing PBL in this context demonstrates that student-centered and inquiry-based learning models are applicable and effective in madrasah settings. This finding supports the argument that innovative instructional models can be successfully adapted in diverse educational environments when supported by appropriate teacher facilitation and reflective practice (Darling-Hammond, 2017).

Although the results of this study indicate strong improvement, it is important to acknowledge that PBL implementation requires careful planning and sufficient instructional time. Students need repeated practice to become familiar with inquiry-based learning patterns, and teachers must develop strong facilitation skills to guide reasoning processes effectively. Without these factors, PBL may not produce optimal outcomes. This is consistent with the view that PBL effectiveness depends on the quality of instructional design and scaffolding (Hmelo-Silver et al., 2007).

The findings confirm that Problem-Based Learning is an effective approach for improving students' logical thinking skills in mathematics learning. The significant improvement in test results, student activity, and teacher performance demonstrates that PBL supports deeper reasoning development by encouraging contextual problem analysis, collaborative inquiry, systematic solution planning, and reflective conclusion drawing. These outcomes indicate that PBL can be recommended as an instructional strategy to enhance logical thinking competence in elementary mathematics classrooms, particularly in madrasah educational contexts.

## **Conclusion**

This classroom action research concludes that the implementation of the Problem-Based Learning (PBL) model effectively improved students' logical thinking skills in mathematics learning at MIN Payaseunara. The improvement was evidenced by the increase in students' mean scores from 59.21 in the pre-cycle stage to 70.46 in Cycle I and reaching 82.14 in Cycle II, accompanied by an increase in mastery learning from 39.29% to 67.86% and ultimately 89.29%. In addition to enhancing learning outcomes, the PBL model also strengthened the learning process, as reflected in the improvement

of teacher activity from 72.50% to 90.00% and student learning activity from 68.75% to 88.50%. These findings confirm that PBL encourages students to engage in contextual problem analysis, collaborative inquiry, systematic reasoning, and reflective conclusion drawing, thereby fostering deeper conceptual understanding and structured logical thinking. Therefore, Problem-Based Learning can be recommended as an effective instructional approach to enhance logical thinking competence in elementary mathematics education, particularly in madrasah contexts, while future research may explore its long-term impact and broader application across different mathematical topics and grade levels.

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