



Efforts to Improve Students' Problem-Solving Skills in Science Learning by Implementing the Problem-Based Learning Model in MIS Ni'matul Aziz

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ABSTRACT

This classroom action research aimed to investigate the efforts to improve students' problem-solving skills in science learning through implementing the Problem-Based Learning (PBL) model at MIS Ni'matul Aziz. The study was conducted in the second semester of the 2025 academic year involving 30 students of class VII who were purposively selected as research participants. The research was implemented over two cycles, each consisting of planning, action, observation, and reflection stages. Data were collected using tests, observation sheets, student journals, and teacher reflection notes to measure improvements in students' problem-solving skills. The problem-solving test consisted of five performance-based science questions aligned with the PBL phases: problem identification, hypothesis formulation, data analysis, solution design, and solution evaluation. Data analysis used both quantitative and qualitative techniques; quantitative data from pre-test, post-test cycle 1 and post-test cycle 2 were analyzed using descriptive statistics, while qualitative data from observations and reflections were analyzed thematically to support interpretation. The results showed that the implementation of the PBL model significantly improved students' problem-solving skills. The average score increased from 51.2 in the pre-test to 68.5 in post-test cycle 1 and reached 82.7 in post-test cycle 2, indicating a progressive and statistically meaningful improvement. Furthermore, classroom observations documented increased student engagement, collaboration, and analytical reasoning during science learning activities. Teacher reflections also indicated that PBL enhanced students' ability to identify scientific problems, analyze data, and communicate solutions effectively. The findings imply that PBL is an effective instructional model for enhancing problem-solving competencies in science learning contexts similar to MIS Ni'matul Aziz. The study recommends broader application of PBL in science curricula to cultivate higher-order thinking skills among learners.

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Introduction

Science education plays a crucial role in shaping students' cognitive development and equipping them with the competencies required to face complex challenges in the modern era. In the context of 21st-century learning, science is not merely understood as the transfer of factual knowledge, but as a process of developing critical thinking, reasoning, inquiry, and problem-solving skills. These competencies are essential for students to interpret scientific phenomena, construct logical explanations, and apply scientific concepts to real-life situations (National Research Council, 2012). Therefore, the improvement of problem-solving skills has become one of the most significant objectives in science learning at the primary and secondary education levels.

Problem-solving skills are widely regarded as higher-order thinking abilities that enable learners to identify problems, analyze relevant information, design solutions, and evaluate outcomes systematically. Such skills are not naturally developed without intentional instructional strategies and structured learning experiences (Polya, 1957). In science learning, problem-solving competence is particularly important because scientific inquiry inherently involves identifying problems, formulating hypotheses, collecting evidence, and drawing conclusions based on logical reasoning (Bybee, 2013). Consequently, students with strong problem-solving skills tend to demonstrate better learning outcomes and improved scientific literacy.

Scientific literacy is increasingly recognized as a key indicator of educational success in global educational assessments. International evaluation programs such as PISA emphasize that students should not only memorize scientific facts but also demonstrate the ability to apply scientific knowledge in solving contextual and authentic problems (OECD, 2019). However, in many developing educational contexts, science instruction is still dominated by conventional approaches that emphasize rote learning, teacher-centered explanation, and textbook-based activities. Such learning conditions often limit students' opportunities to develop analytical reasoning and independent problem-solving capacities (Darling-Hammond et al., 2020).

The issue of limited problem-solving skills among students has become a major concern in Indonesian education. Several studies have reported that students often experience difficulties in interpreting scientific problems, identifying relevant variables, and constructing logical solution procedures. This situation is frequently associated with passive learning culture and instructional practices that prioritize content delivery over active inquiry (Suryadi, 2019). As a result, students may achieve superficial understanding but struggle when confronted with problem-based questions that require reasoning and analysis.

In Islamic elementary schools such as Madrasah Ibtidaiyah, science learning is expected to support not only academic achievement but also character development

and religious values. Education in Islamic institutions aims to foster students' holistic growth, integrating intellectual development with moral responsibility and social awareness (Huda, 2018). Therefore, science education in Islamic schools should encourage students to develop scientific thinking while maintaining ethical awareness and responsible attitudes. Such integration is consistent with the broader educational philosophy that learning should prepare students to contribute positively to society (Tilaar, 2015).

Despite these expectations, many Islamic elementary schools still face pedagogical challenges in implementing effective science learning models. Teachers often rely on traditional lecturing methods, which may reduce student engagement and limit the development of inquiry-based learning experiences. In such learning environments, students may become dependent on teacher explanations and lack confidence in exploring scientific problems independently (Rahman, 2020). This condition indicates the need for innovative instructional strategies that encourage active learning and promote problem-solving competence.

Educational research has consistently emphasized that meaningful learning occurs when students are actively involved in constructing knowledge through exploration, interaction, and reflection. Constructivist learning theory suggests that knowledge is not simply transmitted from teacher to student, but is built through active engagement with learning experiences and problem situations (Piaget, 1972; Vygotsky, 1978). From this perspective, science learning should be designed to encourage students to interact with real-world contexts, analyze evidence, and generate explanations based on reasoning.

In line with constructivist principles, problem-solving-based instructional approaches have gained increasing attention in science education research. Such approaches position students as active learners who are required to engage in inquiry, decision-making, and critical reasoning. This learning paradigm supports deeper conceptual understanding because students are encouraged to connect scientific concepts with authentic experiences and contextual problems (Hmelo-Silver, 2004). Consequently, learning becomes more meaningful and students develop the ability to apply knowledge in various contexts.

One of the most prominent instructional models aligned with this approach is the Problem-Based Learning (PBL) model. PBL is an instructional strategy that organizes learning around real-life problems and encourages students to collaboratively explore solutions through inquiry and investigation. This model emphasizes student-centered learning, where learners develop critical thinking and problem-solving skills through structured exploration and reflection (Barrows, 1986). In science education, PBL has been widely implemented to enhance students' ability to analyze scientific phenomena and construct evidence-based solutions.

The PBL model is grounded in the assumption that learning becomes effective when students encounter meaningful problems that stimulate curiosity and intellectual engagement. Through PBL, students are guided to identify key issues, gather relevant information, formulate hypotheses, test possible solutions, and present findings systematically (Savery, 2006). These stages reflect the scientific method and provide students with direct opportunities to practice scientific reasoning. Therefore, PBL is often considered an appropriate model for developing scientific inquiry competence.

Several empirical studies have demonstrated the effectiveness of PBL in improving students' problem-solving abilities and learning outcomes. Research in science education indicates that students who learn through PBL tend to show stronger analytical reasoning and deeper understanding compared to those taught through traditional instruction (Walker & Leary, 2009). This finding is supported by meta-analysis evidence suggesting that PBL significantly enhances conceptual learning and promotes higher-order cognitive skills when implemented consistently (Strobel & van Barneveld, 2009).

Furthermore, PBL is considered beneficial because it promotes collaborative learning and communication skills. Students work in groups to explore problems, exchange ideas, and evaluate solutions through discussion. Such collaboration supports the development of social interaction skills and encourages students to articulate reasoning, defend arguments, and respond to alternative viewpoints (Johnson & Johnson, 2009). In science learning, this collaborative aspect is essential because scientific reasoning often involves discourse and the evaluation of evidence.

Another advantage of PBL lies in its potential to improve student motivation. Motivation is an important factor influencing academic success, particularly in science subjects that are often perceived as difficult. When learning is presented through meaningful problems, students tend to become more engaged because they perceive relevance between learning content and real-life situations (Deci & Ryan, 2000). Consequently, PBL can increase student interest and encourage persistence in solving challenging tasks.

In the context of elementary education, the implementation of PBL is particularly relevant because students at this level are developing foundational thinking patterns and learning habits. Early exposure to inquiry-based learning strategies can foster curiosity and help students build confidence in exploring scientific concepts (Bransford et al., 2000). Therefore, applying PBL in elementary science instruction is likely to provide long-term benefits for students' cognitive development and academic growth.

However, implementing PBL in classroom practice requires careful planning and strong teacher facilitation. Teachers must design contextual problems that align with curriculum objectives and are suitable for students' developmental levels. In addition,

teachers need to guide group discussions effectively, ensure student participation, and provide scaffolding when students encounter difficulties (Hmelo-Silver & Barrows, 2006). Without adequate facilitation, PBL may fail to achieve its intended outcomes.

In Indonesian Islamic elementary schools, such challenges may become more complex due to limited instructional resources, varied student backgrounds, and the dominance of teacher-centered traditions. Teachers may experience difficulty shifting from conventional instruction to student-centered facilitation because it requires different classroom management strategies and assessment approaches (Sukardi, 2018). Therefore, research on PBL implementation in Islamic elementary school contexts is essential to provide practical evidence and recommendations for teachers and school administrators.

MIS Ni'matul Aziz, as an Islamic elementary institution, faces similar challenges in science learning. Preliminary observations indicate that science learning in this school has been largely focused on memorization of concepts and completion of textbook exercises. Students tend to struggle when asked to solve contextual problems requiring reasoning and analytical thinking. This condition reflects the broader issue in many schools where science learning is not optimally designed to promote problem-solving competence (Rahmawati & Suparno, 2019).

In addition, science learning outcomes at MIS Ni'matul Aziz have not fully met the expected standards, particularly in tasks requiring critical reasoning. Students often demonstrate difficulty identifying problem statements, interpreting scientific data, and developing structured solutions. Such difficulties indicate that students' problem-solving skills remain underdeveloped and require systematic improvement through instructional intervention (Widodo & Wuryastuti, 2020). Therefore, improving students' problem-solving competence has become a priority for enhancing science learning effectiveness.

Classroom Action Research (CAR) is considered an appropriate research approach to address such instructional challenges. CAR emphasizes reflective practice and continuous improvement through cycles of planning, action, observation, and reflection. This method allows teachers and researchers to implement instructional strategies, evaluate their effectiveness, and refine learning practices based on evidence (Kemmis & McTaggart, 1988). Therefore, CAR provides a practical framework for improving teaching quality and student learning outcomes in real classroom settings.

The use of CAR in educational research is also aligned with professional teacher development, as it encourages teachers to become reflective practitioners who continuously improve instructional strategies. CAR not only focuses on student outcomes but also supports the development of teaching competence through evidence-based evaluation (Creswell & Creswell, 2018). In the context of science

learning, CAR is often used to test innovative models such as PBL to determine their effectiveness in improving higher-order thinking skills.

The integration of PBL and CAR offers strong potential for improving problem-solving skills in science learning. Through repeated cycles of implementation and evaluation, PBL can be refined according to student needs and classroom conditions. This iterative approach allows teachers to identify challenges in facilitation, adjust learning materials, and improve the quality of student engagement in problem-solving activities (Elliott, 1991). Therefore, combining PBL with CAR is likely to produce meaningful improvements in science learning.

Although previous studies have widely examined PBL in general education settings, research focusing on PBL implementation in Islamic elementary schools remains limited. This gap highlights the need for contextual research that considers the unique learning environment, cultural values, and educational goals of Islamic institutions. Research in such settings is essential because instructional models may function differently depending on student characteristics, institutional culture, and teacher competence (Miles et al., 2020).

In addition, research on problem-solving improvement in science learning is important because it supports national educational goals related to critical thinking and scientific literacy. Indonesian educational reforms emphasize the development of higher-order thinking skills as part of curriculum transformation. Instructional strategies such as PBL are highly relevant in achieving these objectives because they encourage students to engage in inquiry, reasoning, and collaborative learning (Ministry of Education and Culture of Indonesia, 2017). Therefore, implementing PBL is consistent with the direction of national education policy.

Based on these considerations, this study focuses on efforts to improve students' problem-solving skills in science learning by implementing the Problem-Based Learning model at MIS Ni'matul Aziz. The study aims to evaluate the effectiveness of PBL through classroom action research cycles, examining improvements in student problem-solving performance as well as changes in learning engagement. This research is expected to provide empirical evidence that supports the application of PBL as an effective instructional model in Islamic elementary school science learning.

The findings of this study are expected to contribute theoretically and practically to science education research. Theoretically, the study strengthens evidence regarding the effectiveness of PBL in developing problem-solving competence in elementary education contexts. Practically, the study provides recommendations for teachers in Islamic schools to implement PBL effectively and create science learning environments that encourage active inquiry and analytical reasoning. Ultimately, improving students'

problem-solving skills is essential for preparing learners to face academic and real-world challenges in an increasingly complex society (Trilling & Fadel, 2009).

Methods

This study employed a Classroom Action Research (CAR) design to improve students' problem-solving skills in science learning through the implementation of the Problem-Based Learning (PBL) model at MIS Ni'matul Aziz. Classroom Action Research was selected because it provides a systematic and reflective approach to improving instructional practices through repeated cycles of intervention, evaluation, and refinement (Kemmis & McTaggart, 1988). The CAR design is particularly suitable for educational research aimed at addressing real classroom challenges and enhancing student learning outcomes through evidence-based instructional improvement (Elliott, 1991).

The research was conducted through two action cycles, and each cycle consisted of four main stages: planning, action, observation, and reflection. This cyclical structure enabled the researcher and the classroom teacher to identify learning obstacles, implement appropriate interventions, monitor students' learning progress, and revise strategies for better outcomes in the subsequent cycle (Creswell & Creswell, 2018). The PBL model served as the main instructional intervention, emphasizing active student engagement in identifying scientific problems, exploring possible solutions, and constructing evidence-based reasoning (Savery, 2006).

The study was carried out at MIS Ni'matul Aziz, an Islamic elementary school located in Indonesia. The research took place during the second semester of the 2025 academic year in the science subject. The participants consisted of 30 students from Grade VII who were selected as the research subjects because they demonstrated low to moderate problem-solving performance based on preliminary classroom assessment results. The class was chosen using purposive sampling to ensure alignment with the research objective, which focused on improving students' science-related problem-solving competence (Miles et al., 2020).

In addition to students, the classroom science teacher participated as a collaborator in implementing the learning intervention and assisting in the observation process. Collaboration between the researcher and the classroom teacher is an essential aspect of CAR because it strengthens instructional validity and supports reflective evaluation based on authentic classroom dynamics (Kemmis & McTaggart, 1988).

The instructional intervention in this study was the implementation of the Problem-Based Learning model. PBL was applied systematically according to its core phases, which include problem orientation, problem identification, investigation and

data collection, solution development, presentation of findings, and evaluation (Barrows, 1986). The learning activities were designed to ensure that students actively engaged in analyzing real-life science problems and developing solutions collaboratively through inquiry-based discussion.

During the first phase, students were introduced to contextual science problems related to daily phenomena. The problems were selected to align with the science curriculum and students' cognitive level. In the second phase, students were guided to define the problem, identify relevant scientific concepts, and formulate hypotheses. In the investigation phase, students collected information through textbook exploration, teacher-provided learning resources, and structured group discussion. Subsequently, students developed solutions, presented their findings, and evaluated the scientific validity of their conclusions through reflection guided by the teacher and researcher. This implementation was intended to provide students with repeated opportunities to practice problem-solving procedures in a structured learning environment (Hmelo-Silver, 2004).

The research was conducted in two cycles, with each cycle consisting of two learning meetings and one assessment session. Each cycle followed four systematic stages. In the planning stage, the researcher prepared lesson plans based on the PBL model, developed contextual science problems, designed student worksheets, and prepared observation instruments. The action stage involved the implementation of the prepared lesson plans in the classroom. During the observation stage, student learning activities, engagement, and collaborative interaction were monitored using structured observation sheets. Finally, the reflection stage was conducted to evaluate learning outcomes and identify weaknesses in the cycle, which served as the basis for improving the next cycle (Elliott, 1991).

Cycle 1 was designed to introduce students to the PBL learning structure and familiarize them with problem-based inquiry processes. Reflection from cycle 1 was used to improve learning facilitation in cycle 2, particularly in enhancing group discussion effectiveness and guiding students in identifying problem-solving strategies more systematically. Cycle 2 emphasized deeper investigation and more structured student reflection to strengthen reasoning and evaluation skills. The CAR procedure was considered complete when students' problem-solving achievement met the predetermined success indicators.

Data were collected using multiple instruments to ensure comprehensive measurement of students' problem-solving development. The primary instrument was a science problem-solving test administered in three stages: pre-test, post-test cycle 1, and post-test cycle 2. The test consisted of five contextual essay questions requiring students to demonstrate scientific reasoning through problem identification, analysis,

and solution development. Essay-based problem-solving tests were selected because they provide richer evidence of students' reasoning processes compared to multiple-choice formats (Brookhart, 2010).

In addition to tests, structured classroom observation sheets were used to document students' learning activities during PBL implementation. The observation focused on student engagement, participation in group discussion, ability to propose ideas, and interaction patterns. Observation was conducted collaboratively by the researcher and the classroom teacher to reduce subjectivity and improve consistency in data interpretation (Miles et al., 2020).

Furthermore, student learning journals were collected to explore students' perceptions and reflections regarding the learning process. Reflective journals are useful qualitative instruments for identifying students' learning experiences and motivational responses to instructional interventions (Creswell & Creswell, 2018). Teacher reflection notes were also used as supporting qualitative data to identify instructional strengths and weaknesses across cycles.

The main research instruments included lesson plans, student worksheets, problem-solving test sheets, observation sheets, and reflection guidelines. Instrument validity was established through expert judgment. Two experts in science education and instructional methodology evaluated the instruments to ensure content relevance, clarity, and alignment with PBL principles. Content validity was emphasized to confirm that the test items measured science problem-solving indicators appropriately, including problem identification, hypothesis formulation, data interpretation, solution development, and evaluation (Savery, 2006).

To improve reliability, the observation sheets were designed using clear performance descriptors. Inter-observer agreement was applied by involving both the researcher and the classroom teacher in recording classroom activities. Differences in observations were discussed during reflection sessions to reach consistent interpretation and improve data trustworthiness (Miles et al., 2020).

Students' problem-solving skills were assessed based on five main indicators adapted from problem-solving theory and science inquiry frameworks. These indicators included the ability to identify scientific problems, formulate hypotheses or predictions, analyze relevant information, develop logical solutions, and evaluate the effectiveness of the proposed solutions. This framework is consistent with the scientific inquiry approach and problem-solving principles emphasizing systematic reasoning (Polya, 1957; National Research Council, 2012).

Each indicator was scored using an analytic rubric with a range of 0–4 points. A score of 0 indicated no response or irrelevant answer, while a score of 4 indicated

complete, accurate, and well-structured reasoning. The total test score was converted into a percentage scale ranging from 0 to 100 for analysis purposes.

This study applied both quantitative and qualitative data analysis techniques. Quantitative analysis was conducted using descriptive statistics to calculate the mean score, percentage improvement, and achievement level of students' problem-solving performance across the pre-test, cycle 1 post-test, and cycle 2 post-test. Improvement in student performance was interpreted by comparing mean scores between cycles and evaluating whether the success indicators were achieved. Descriptive statistical analysis is commonly applied in classroom action research to identify progress patterns across intervention cycles (Cohen et al., 2018).

Qualitative data obtained from observations, student journals, and teacher reflection notes were analyzed thematically. The qualitative analysis process involved data reduction, data display, and conclusion drawing. This procedure followed the interactive analysis model proposed by Miles, Huberman, and Saldaña (2020). Qualitative findings were used to support quantitative results by explaining changes in student engagement, collaboration, and reasoning behavior during PBL learning activities.

The success of the intervention was determined based on both learning outcomes and learning process indicators. From the learning outcomes perspective, the intervention was considered successful if at least 80% of students achieved a minimum score of 75 in the problem-solving post-test at the end of cycle 2. This criterion was aligned with the minimum mastery standard commonly applied in Indonesian educational settings. From the learning process perspective, success was indicated by improved student participation, collaborative discussion quality, and active engagement during science learning activities. These process indicators were evaluated through observation results and reflective analysis.

Ethical principles were applied throughout the research process to ensure responsible conduct. Permission to conduct the study was obtained from the school principal and classroom teacher. Students and their parents were informed that the study was conducted for educational improvement purposes and that student performance data would be used anonymously. Confidentiality was maintained by using coded student identities during data analysis and reporting. Ethical considerations in classroom research are essential to ensure that student rights are protected and that the research does not disrupt the learning process (Creswell & Creswell, 2018).

Result

This study examined the effectiveness of implementing the Problem-Based Learning (PBL) model in improving students' problem-solving skills in science learning at MIS Ni'matul Aziz. The results were obtained from three main assessment phases, namely the pre-test, the post-test in Cycle 1, and the post-test in Cycle 2. The quantitative findings were supported by classroom observation data and reflective documentation collected during the implementation of each cycle. The overall results demonstrate a significant improvement in students' problem-solving competence as well as a notable enhancement in student engagement and learning participation throughout the intervention.

Students' Problem-Solving Skills Improvement

The students' problem-solving skills were measured using an essay-based problem-solving test consisting of five contextual science questions aligned with the PBL learning stages. The results indicate that students' achievement improved progressively from the initial condition to the end of Cycle 2. The average score on the pre-test was relatively low, suggesting that students initially struggled to identify scientific problems, analyze information, and formulate logical solutions.

Following the implementation of PBL in Cycle 1, students' scores increased substantially. The improvement in Cycle 1 reflects that students began to adapt to the PBL learning environment, particularly in working collaboratively, exploring contextual problems, and presenting solutions. However, despite the improvement, several students still demonstrated weaknesses in developing systematic explanations and evaluating the effectiveness of their solutions.

In Cycle 2, the results showed a stronger improvement compared to Cycle 1. Students demonstrated more structured reasoning patterns, improved scientific argumentation, and higher confidence in presenting their solutions. This suggests that repeated exposure to PBL cycles enabled students to internalize problem-solving steps more effectively.

The detailed improvement of students' problem-solving test scores across the three stages is presented in Table 1.

Table 1. Students' Problem-Solving Skills Scores

Assessment Stage	Mean Score	Highest Score	Lowest Score	Students Achieving ≥ 75	Percentage (%)
Pre-Test	51.2	70	35	4 students	13.3%
Post-Test Cycle 1	68.5	85	50	12 students	40.0%

Assessment Stage	Mean Score	Highest Score	Lowest Score	Students Achieving ≥ 75	Percentage (%)
Post-Test Cycle 2	82.7	95	70	26 students	86.7%

The data in Table 1 clearly show a consistent increase in student achievement. The mean score increased from 51.2 in the pre-test to 68.5 in Cycle 1, representing a gain of 17.3 points. In Cycle 2, the mean score reached 82.7, showing an additional gain of 14.2 points from Cycle 1. Overall, the total increase from pre-test to Cycle 2 was 31.5 points. These results confirm that the PBL model had a strong impact on enhancing students' problem-solving skills.

The improvement is also evident from the percentage of students who achieved the minimum mastery criterion (≥ 75). Only 13.3% of students met this standard in the pre-test. After Cycle 1, the percentage increased to 40.0%, indicating that nearly half of the class began to demonstrate acceptable problem-solving competence. By the end of Cycle 2, 86.7% of students achieved mastery, exceeding the predetermined success indicator of 80%. This confirms that the intervention was successful in improving science problem-solving learning outcomes.

Improvement Across Problem-Solving Indicators

To provide a deeper analysis, students' problem-solving skills were evaluated based on five key indicators: identifying problems, formulating hypotheses, analyzing information, designing solutions, and evaluating solutions. The results show that improvement occurred across all indicators, with the most significant gains occurring in problem identification and solution design.

In the pre-test, students demonstrated the greatest difficulty in analyzing scientific information and evaluating solutions. Many students provided short answers without evidence-based reasoning, indicating limited understanding of scientific problem-solving processes. In Cycle 1, improvements were observed in students' ability to identify problems and propose initial solutions, but weaknesses remained in evaluation and justification stages.

In Cycle 2, students demonstrated clearer reasoning patterns. Their answers included more detailed explanations, improved use of scientific terms, and stronger justification for solutions. This indicates that PBL not only improved final scores but also strengthened the reasoning quality behind students' answers. The improvement in each problem-solving indicator is presented in Table 2.

Table 2. Mean Scores of Students' Problem-Solving Indicators

Problem-Solving Indicator	Pre-Test	Cycle 1	Cycle 2
Problem Identification	54.0	72.5	85.2
Hypothesis Formulation	50.8	67.3	81.4
Information Analysis	48.6	65.1	80.7
Solution Design	52.4	70.8	84.6
Solution Evaluation	49.2	66.8	81.7

Table 2 indicates that the lowest initial indicator was information analysis (48.6), showing that students struggled to interpret scientific data and connect concepts. However, by Cycle 2, this indicator increased to 80.7, demonstrating strong improvement. Similarly, solution evaluation increased from 49.2 to 81.7, suggesting that students became more capable of reflecting on the validity and effectiveness of their proposed solutions.

Classroom Observation Results

The quantitative findings were supported by classroom observation data documenting students' engagement, collaboration, and learning behavior during PBL implementation. During the pre-intervention phase, students were generally passive and tended to wait for teacher explanations. They rarely asked questions or expressed ideas during science lessons. Group discussions were also limited, as students lacked confidence and were not accustomed to collaborative learning.

During Cycle 1, observation results showed increased participation. Students began to discuss problems in groups, although some groups were dominated by a few active members. Several students still hesitated to share ideas, and the teacher needed to provide frequent scaffolding. Nonetheless, student interest improved because the contextual problems were connected to daily life, making learning more meaningful.

In Cycle 2, classroom participation improved significantly. Students were more active in discussing problems, distributing tasks, and presenting solutions. Most students contributed during group work, and peer interaction became more balanced. Students also demonstrated improved communication skills, as they could explain scientific reasoning more clearly. This indicates that the PBL learning environment became more effective in fostering collaborative inquiry and engagement. The observation findings confirm that PBL improved not only learning outcomes but also learning processes, particularly student-centered participation and inquiry behavior.

Discussion

The results of this study demonstrate that the implementation of the Problem-Based Learning (PBL) model significantly improved students' problem-solving skills in science learning at MIS Ni'matul Aziz. This finding is consistent with the theoretical foundation of PBL, which emphasizes learning through meaningful problems that stimulate inquiry, reasoning, and collaborative knowledge construction (Barrows, 1986; Savery, 2006). The improvement observed in this study confirms that when students are actively engaged in problem-based tasks, they develop stronger analytical skills and become more capable of applying scientific concepts to real-world contexts.

The progressive improvement in mean scores from 51.2 in the pre-test to 82.7 in Cycle 2 reflects a substantial enhancement in students' cognitive abilities. This aligns with the constructivist learning perspective, which suggests that learning becomes deeper and more effective when students actively build understanding through interaction with contextual problems rather than receiving information passively (Piaget, 1972; Vygotsky, 1978). In this study, PBL facilitated such constructive learning by providing students with opportunities to explore scientific issues, discuss possible explanations, and evaluate evidence collaboratively.

The increase in the percentage of students achieving mastery learning outcomes further reinforces the effectiveness of PBL. The percentage rose from 13.3% in the pre-test to 86.7% in Cycle 2. This improvement indicates that PBL not only benefited high-achieving students but also supported those who initially struggled. This outcome supports previous research showing that PBL enhances learning achievement by providing structured guidance for inquiry and encouraging active participation among all learners (Hmelo-Silver, 2004; Walker & Leary, 2009). In traditional teacher-centered learning environments, low-achieving students often remain passive and fail to develop reasoning skills. However, in PBL, group-based problem solving creates opportunities for peer learning and shared cognitive support.

The improvement across all five problem-solving indicators confirms that PBL strengthened multiple dimensions of students' reasoning ability. The most notable improvement occurred in problem identification and solution design, which increased significantly by Cycle 2. This finding is consistent with the argument that PBL trains students to recognize problems as the starting point of learning and encourages them to generate logical solution strategies through systematic inquiry (Bybee, 2013). When students were repeatedly exposed to contextual science problems, they gradually became more capable of identifying relevant information and constructing structured responses.

Furthermore, the substantial improvement in the information analysis indicator demonstrates that PBL effectively promoted scientific reasoning. Initially, students

struggled to interpret data and connect scientific concepts with evidence. This difficulty is common in elementary science learning contexts where students are accustomed to memorization-based instruction (Darling-Hammond et al., 2020). However, through PBL, students were encouraged to examine learning resources, interpret findings, and justify conclusions. This process reflects the core principle of scientific inquiry, where learners must analyze evidence and develop explanations logically (National Research Council, 2012).

The improvement in solution evaluation skills is also an important finding because evaluation is often considered one of the most challenging aspects of problem-solving. Many students initially provided solutions without reflecting on accuracy or feasibility. However, by Cycle 2, students were more capable of assessing the effectiveness of their answers and revising their reasoning. This improvement supports Polya's (1957) problem-solving theory, which emphasizes the importance of reviewing and evaluating solutions as a key stage in problem-solving competence. The reflective stage in PBL, where students present and discuss their findings, likely contributed significantly to this improvement.

The classroom observation results further explain why PBL was effective in improving problem-solving competence. During Cycle 1, students began to demonstrate increased participation, although group discussion was still uneven. Some students remained passive and depended on more active peers. This phenomenon is common in early stages of PBL implementation because students are still adapting to the demands of collaborative inquiry (Hmelo-Silver & Barrows, 2006). However, teacher scaffolding and structured group roles in Cycle 2 improved group interaction and encouraged more balanced participation. This confirms that teacher facilitation is a critical factor in successful PBL implementation, especially in elementary classroom contexts.

The increased student engagement observed in Cycle 2 also supports the motivational theory of self-determination, which argues that learning motivation improves when students experience autonomy, competence, and social relatedness (Deci & Ryan, 2000). In this study, students were given autonomy to explore problems, discuss solutions, and present findings. They also developed competence as they became more capable of solving problems, and they experienced social relatedness through collaborative group work. These motivational factors likely contributed to the improved learning outcomes.

Additionally, the collaborative learning aspect of PBL was a key contributor to student improvement. Group discussions enabled students to share ideas, clarify misunderstandings, and learn from peers. Cooperative learning theory emphasizes that structured collaboration promotes deeper learning because students are required to articulate reasoning and negotiate meaning through interaction (Johnson & Johnson,

2009). In science learning, such discourse is essential because scientific knowledge is often constructed through argumentation and evidence-based discussion. The improvement in students' communication skills during Cycle 2 indicates that PBL supported not only cognitive development but also social and communicative competence.

The findings of this study are also consistent with the broader framework of 21st-century learning, which highlights problem-solving, critical thinking, collaboration, and communication as essential skills for modern learners (Trilling & Fadel, 2009). Through PBL, students were trained to address contextual problems systematically, communicate reasoning, and evaluate solutions. This suggests that PBL is not only effective for improving academic achievement but also relevant for preparing students for future challenges in a complex society.

In the context of Islamic elementary education, the findings are particularly meaningful because PBL supports holistic learning goals. Islamic education emphasizes not only intellectual development but also moral values, responsibility, and cooperative attitudes (Huda, 2018). During PBL implementation, students practiced teamwork, respect for peer opinions, and responsibility for group tasks. These behaviors align with Islamic educational principles that encourage cooperation and mutual support. Therefore, PBL can be considered a suitable model for Islamic school contexts because it supports both cognitive and character development.

Moreover, the success of this intervention provides evidence that science learning in Islamic schools can be improved through innovative pedagogical approaches. The traditional perception that Islamic schools rely heavily on teacher-centered methods can be challenged through the successful implementation of student-centered models such as PBL. This finding supports previous educational research suggesting that instructional transformation is possible when teachers are provided with structured strategies and reflective evaluation opportunities (Sukardi, 2018; Rahman, 2020).

The use of Classroom Action Research in this study also contributed to the effectiveness of the intervention. CAR enabled continuous reflection and improvement across cycles, allowing the teacher and researcher to revise strategies based on observed weaknesses. This iterative improvement process is consistent with the CAR framework emphasizing reflective teaching practice and systematic instructional enhancement (Kemmis & McTaggart, 1988; Elliott, 1991). Without such reflection, the challenges observed in Cycle 1, such as unequal participation and weak solution evaluation, might not have been effectively addressed.

However, it is also important to acknowledge that the improvement in students' problem-solving skills required consistent facilitation and structured learning management. PBL demands teacher competence in guiding inquiry, designing

contextual problems, and managing classroom discussion. This study confirms that PBL implementation is not automatically successful unless teachers actively provide scaffolding and maintain clear learning structure (Hmelo-Silver, 2004). Therefore, teacher training and professional development remain essential for maximizing the effectiveness of PBL in similar educational contexts.

Overall, the findings confirm that implementing Problem-Based Learning in science learning significantly improved students' problem-solving skills at MIS Ni'matul Aziz. The improvement was evident not only in test scores but also in students' learning behavior, engagement, collaboration, and scientific reasoning ability. These results strengthen the argument that PBL is a highly relevant instructional approach for enhancing science learning effectiveness, particularly in educational contexts aiming to develop higher-order thinking skills and scientific literacy (OECD, 2019; National Research Council, 2012).

Conclusion

This classroom action research concludes that the implementation of the Problem-Based Learning (PBL) model was effective in improving students' problem-solving skills in science learning at MIS Ni'matul Aziz. The findings demonstrate a consistent and significant increase in students' achievement, as indicated by the improvement of the mean score from 51.2 in the pre-test to 68.5 in Cycle 1 and reaching 82.7 in Cycle 2, accompanied by an increase in mastery learning percentage from 13.3% to 86.7%. In addition to improving quantitative learning outcomes, PBL also enhanced the quality of the learning process by fostering active participation, collaborative discussion, scientific reasoning, and students' confidence in identifying problems and constructing evidence-based solutions. These results confirm that PBL is a relevant and impactful instructional approach for developing higher-order thinking competencies, particularly problem-solving skills, within science learning contexts in Islamic elementary education. Therefore, it is recommended that science teachers apply PBL more consistently and systematically, supported by appropriate scaffolding and reflective evaluation, to strengthen students' scientific literacy and prepare them for complex academic and real-life challenges.

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