

## IMPROVING STUDENTS' MATHEMATICS LEARNING OUTCOMES THROUGH PROBLEM-BASED LEARNING

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**ABSTRACT** The low level of students' mathematics learning outcomes served as the primary motivation for this study. This research aimed to improve the mathematics learning outcomes of ninth-grade students at Babussalam Junior High School, Pekanbaru, through the implementation of the Problem-Based Learning (PBL) model. The study employed a Classroom Action Research design consisting of two cycles, each comprising the stages of planning, action, observation, and reflection. The participants were 24 students from class IX.3 during the even semester of the 2024/2025 academic year. Data were collected using mathematics achievement tests administered at the end of each cycle. Data analysis focused on comparing students' learning outcomes across the pre-cycle, Cycle I, and Cycle II. The results indicate a significant improvement in students' mathematics learning outcomes following the implementation of the PBL model. The percentage of students achieving the expected level of learning mastery increased from 25% in the pre-cycle to 45.83% in Cycle I, and further rose to 91.66% in Cycle II. These findings demonstrate that the Problem-Based Learning model is effective in improving students' mathematics learning outcomes. Therefore, the application of PBL can be considered a viable instructional approach for enhancing mathematics achievement at the junior secondary level.

**Keywords:** problem-based learning, mathematics learning outcomes, classroom action research, mathematics instruction

**ABSTRAK** Rendahnya capaian hasil belajar matematika peserta didik menjadi latar belakang dilakukannya penelitian ini. Penelitian ini bertujuan untuk meningkatkan hasil belajar matematika peserta didik kelas IX di SMP Babussalam Pekanbaru melalui penerapan model *Problem-Based Learning* (PBL). Penelitian ini menggunakan desain Penelitian Tindakan Kelas yang dilaksanakan dalam dua siklus, masing-masing meliputi tahap perencanaan, pelaksanaan tindakan, observasi, dan refleksi. Subjek penelitian terdiri atas 24 peserta didik kelas IX.3 pada semester genap tahun ajaran 2024/2025. Pengumpulan data dilakukan menggunakan tes hasil belajar matematika yang diberikan pada akhir setiap siklus. Analisis

data difokuskan pada perbandingan hasil belajar peserta didik pada tahap pra-siklus, siklus I, dan siklus II. Hasil penelitian menunjukkan adanya peningkatan hasil belajar matematika setelah penerapan model PBL. Persentase peserta didik yang mencapai tingkat ketuntasan belajar meningkat dari 25% pada pra-siklus, menjadi 45,83% pada siklus I, dan meningkat secara signifikan menjadi 91,66% pada siklus II. Temuan ini menunjukkan bahwa penerapan model *Problem-Based Learning* efektif dalam meningkatkan hasil belajar matematika peserta didik. Dengan demikian, model PBL dapat dijadikan sebagai salah satu alternatif strategi pembelajaran untuk meningkatkan hasil belajar matematika pada jenjang sekolah menengah pertama.

**Kata-kata kunci:** problem-based learning, hasil belajar matematika, penelitian tindakan kelas, pembelajaran matematika

## INTRODUCTION

Education plays a fundamental role in human development, as it enables individuals to grow intellectually and socially and to participate meaningfully in society. Every individual has the right to education and is expected to develop within an educational environment (Alpian et al., 2019). Among school subjects, mathematics holds a central position because of its wide applicability in daily life and its contribution to the development of logical, analytical, and problem-solving skills. Mathematics supports human cognitive development across various domains. However, despite its importance, mathematics is often perceived by students as a difficult and less engaging subject. Several studies have reported that students experience difficulties in understanding mathematical concepts, which can lead to negative attitudes toward mathematics and decreased learning motivation (Hasanah, 2023).

In mathematics education, learning is expected to enable students to master mathematical concepts, facts, operations, and relationships, and to apply them effectively when solving problems. Achieving these objectives requires continuous instructional effort and appropriate learning strategies (Darma et al., 2022). Students' learning outcomes serve as important indicators of whether instructional goals have been successfully achieved. Learning outcomes are commonly defined as the competencies and skills acquired by students after participating in the learning process (Nugraha, 2020). Furthermore, learning outcomes reflect changes in students' knowledge, skills, and behavior as a result of learning experiences and provide teachers with information about students' progress toward instructional objectives (Bunyamin, 2021).

From a theoretical perspective, mathematics learning outcomes represent the skills students possess after completing the learning process (Gagné, as cited in Agussantri et al., 2020). These outcomes are generally determined through assessment activities that take place throughout and at the end of instruction. Assessment is understood as a systematic and continuous process of collecting, analyzing, and interpreting information related to students' learning processes and

results (Putri & Zakir, 2023). Through assessment, teachers are able to evaluate students' understanding and determine the extent to which learning objectives have been achieved.

Assessment practices in mathematics education typically include formative and summative assessments. Formative assessment is conducted during the learning process and is used to support instructional decision-making by helping teachers adjust teaching strategies to improve students' understanding (Putri & Zakir, 2023). In contrast, summative assessment is conducted at the end of a learning period to evaluate students' overall achievement and mastery of the subject matter. Students' performance on summative assessments is commonly used as a basis for determining whether expected learning outcomes have been achieved after classroom instruction.

Based on information obtained from the mathematics teacher of class IX.3 at SMP Babussalam Pekanbaru, students' achievement in mathematics remains relatively low. Fewer than half of the students were able to achieve the expected level of mastery, particularly in the topic of similarity. Specifically, only 6 out of 24 students met the expected standard, indicating that a considerable proportion of students have not yet achieved satisfactory mathematics learning outcomes.

To gain deeper insight into this issue, the researcher conducted discussions with three students from class IX.3 representing different levels of academic ability. The results of these discussions revealed that students often perceive mathematics lessons as monotonous and difficult due to the large number of formulas and numerical procedures involved. Classroom observations further indicated several instructional challenges, including low student engagement, limited interest in learning activities, and difficulties in understanding the material presented by the teacher. These conditions make it challenging for students to solve mathematical problems effectively and contribute to low learning outcomes.

Contemporary educational perspectives emphasize that learning should take place in environments that actively engage students and provide opportunities for them to develop independently. In this context, teachers are expected to act as facilitators rather than as the sole source of knowledge. However, the continued reliance on conventional, teacher-centered instructional methods often results in passive learning environments with limited student participation. Putri et al. (2023) describe conventional instruction as a non-innovative approach that positions students as passive recipients of information. Ideally, learning should be student-centered, participatory, and capable of fostering creativity and critical thinking. In practice, however, lecture-based instruction remains dominant in many classrooms, creating a gap between expected active learning and actual classroom experiences. This situation highlights the need for alternative instructional approaches that promote student engagement (Riswati et al., 2018).

One instructional approach that has the potential to address these challenges is Problem-Based Learning. This approach encourages students to actively engage in learning by connecting instructional content with real-life situations. Problem-Based Learning is widely recognized as an innovative instructional model that develops students' critical thinking skills through the exploration of authentic problems (Surya, 2017).

Problem-Based Learning emphasizes learning that begins with problems encountered by students, which then serve as the starting point for developing new concepts. This approach presents contextual problems that help students understand and apply mathematical concepts in everyday life (Isrok'atun & Rosmala, 2018). Similarly, Problem-Based Learning uses real-world problems as learning resources to facilitate meaningful understanding and active knowledge construction (Widiasworo, as cited in Ardianti et al., 2022).

Considering the learning difficulties identified in class IX.3 at SMP Babussalam Pekanbaru, efforts are needed to improve students' mathematics learning outcomes through more engaging and meaningful instructional approaches. The use of varied learning models has been shown to increase student engagement and participation in the learning process (Riswati et al., 2018). Problem-Based Learning offers a promising alternative because it encourages collaboration, active problem-solving, and the application of mathematical knowledge to real-world contexts.

Research has consistently shown that Problem-Based Learning can enhance students' critical thinking, problem-solving skills, and learning outcomes. The implementation of Problem-Based Learning in mathematics classrooms has been reported to increase student engagement and improve learning outcomes by allowing students to construct their own understanding through collaborative discussion and inquiry (Agustin, 2023). Through these learning activities, students are expected to develop a deeper understanding of mathematical concepts by relating them to real-life situations.

Problem-Based Learning is typically implemented through a series of structured stages, including problem orientation, organization of learning activities, guided individual and group investigations, development and presentation of solutions, and reflection on the problem-solving process (Untari, 2018). These stages provide a clear framework for implementing Problem-Based Learning effectively in classroom instruction.

Based on the discussion above, Problem-Based Learning can be understood as an instructional approach that begins with contextual problems and guides students through a systematic process of inquiry and reflection. This approach aims to develop students' critical thinking skills, problem-solving abilities, and conceptual understanding. Previous studies have demonstrated that the use of Problem-Based Learning can improve students' learning outcomes in mathematics (Irka & Jamaan, 2023; Fadilah et al., 2024). Therefore, considering the learning challenges identified

in class IX.3 at SMP Babussalam Pekanbaru and supported by empirical evidence from prior research, this study applies the Problem-Based Learning model as an instructional strategy to improve students' mathematics learning outcomes in the even semester of the 2024–2025 academic year.

## METHODS

This study employed a Classroom Action Research (CAR) design conducted collaboratively by the researcher and the mathematics teacher. The research followed four iterative stages—planning, action, observation, and reflection—as proposed by Arikunto (2015). The overall research procedure is illustrated in Figure 1.

The research subjects were 24 Grade IX students in the 2024–2025 academic year at SMP Babussalam Pekanbaru. The study was implemented in two cycles. Cycle I consisted of four meetings, including three instructional sessions using the Problem-Based Learning (PBL) model and one achievement test. Cycle II was conducted in three meetings, comprising two instructional sessions and one achievement test. Improvements in Cycle II were based on reflection results from Cycle I to enhance students' understanding and mathematics learning outcomes.

Data were collected using observation sheets, student achievement tests, and field notes. Observation sheets were used to document teacher and student activities during the learning process, while field notes supported reflection and improvement planning. The achievement tests consisted of validated essay-type questions administered at the end of each cycle.

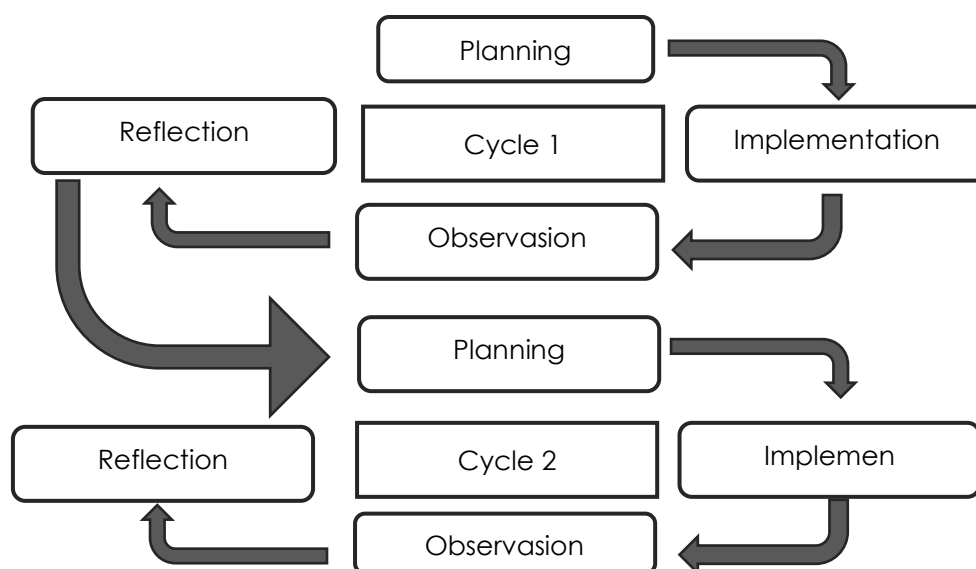


Figure 1. Classroom Action Research Cycle

Data analysis employed descriptive statistics to compare students' learning outcomes across cycles (Arikunto, 2019). Learning improvement was determined by comparing the percentage of students achieving the expected mastery level in the initial condition, Cycle I, and Cycle II. An increase in mastery percentage across cycles indicated improvement in students' mathematics learning outcomes.

To present the distribution of students' learning outcomes clearly, the data were organized using a frequency distribution table, which categorizes achievement levels based on percentage intervals. The criteria used for evaluating learning outcomes are presented in Table 2.

**Table 2.** Frequency Distribution of Learning Outcome Categories

Percentage (%)	Category
0–40%	Beginning to Develop
41–65%	Feasible
66–85%	Proficient
86–100%	Advanced

(Mutadi, 2023)

## FINDING AND DISCUSSION

The purpose of this study was to use the Problem Based Learning approach to improve the learning outcomes for mathematics among students in class IX.3 at SMP Babussalam Pekanbaru. Two cycles of the System of Linear Equations of Two Variables (SPLDV) material were used in this study. The first cycle included an explanation of the two-variable linear equation system, the two-variable linear equation system using the graph technique, and the two-variable linear equation system using the substitution method. The system of linear equations of two variables by elimination technique and the system of linear equations of two variables by combination approach were discussed in the second cycle.

To determine the issues that arise during learning, researchers observed the process and spoke with instructors and students.

### Cycle I

Each cycle of this study employed Learner Worksheets (LKPD), which comprised one meeting for daily exams and three meetings for the learning process. In cycle I, the study was implemented in four stages: preparation, execution, observation, and reflection.

#### Stage of Planning

At this stage, all of the study's equipment is set up. Learning objectives, with a special emphasis on grasping the idea and employing SPLDV, were developed to direct the anticipated student competencies. These goals made sure that every

activity in the class was focused on quantifiable results. Worksheets, issue scenarios, guided exploration tasks, and reflection exercises were all included in the instructional modules that were created using the PBL (issue Based Learning) approach. The modules functioned as organized learning aids to support students' active engagement in resolving contextual, real-world mathematical problems.

In addition, data gathering tools are all part of the planning step. Math learning outcomes test sheets for summative assessments and activity observation sheets for teachers and students are examples of data gathering tools. Based on the students' varied skill levels, the researchers created five study groups with four to five students each.

#### Stage of implementation

Researchers used the Problem Based Learning approach at this point. Three learning process meetings were held in order to achieve this.

#### Stage of observation

At this point in the learning process, observations were done to focus on the actions of both teachers and pupils. The math instructor for class IX.3 SMP Babussalam Pekanbaru made the following observations.

#### Stage of Reflection

At this stage, reflection is carried out to improve the learning process in the next cycle. Reflection on Cycle I revealed that students engaged in individual discussions rather than group discussions. Instead of attempting to answer questions on their own first, some students waited for answers from peers who had already completed their tasks. Students did not ask the teacher for clarification on material they did not understand. Although the learning process proceeded smoothly, it was not fully implemented in accordance with the PBL phase outlined in the Learning Module.

### Cycle II

Cycle II was conducted over the course of two learning processes and one meeting for the final daily exam. As suggested in the reflection of cycle I activities, a number of enhancements and assessment findings were made in cycle II. The following are the phases of cycle II implementation.

#### Stage of Planning

At this point, all of the equipment required for the study was ready. Learning objectives, instructional modules, and data gathering tools are all part of the planning step. Summative exam sheets for math learning outcomes and activity observation sheets for teachers and students served as the instruments used to gather the data. Based on the students' varied skill levels, the researchers created five study groups with four to five students each.

## Stage of implementation

Researchers used the Problem Based Learning approach at this point. Two meetings of the learning process were used to execute this.

## Stage of observation

At this point in the learning process, observations were done to focus on the actions of both teachers and pupils. The math instructor for class IX.3 SMP Babussalam Pekanbaru made the following observations.

## Stage of Reflection

At this point, reflection was done to examine the findings from the observations made throughout the action's execution. The following are a few of the reflection outcomes discovered: Students actively participate in group discussions, learning process activities align with the planned in the Teaching Module, and their comprehension of the teaching material is improving, as evidenced by their ability to convey the findings of their discussions.

The data from cycle I and cycle II test results indicates that pupils' scores are rising. By comparing the percentage of students who met the Learning Objective Completeness Criteria (KKTP) before action (pre-cycle) and after action, namely in the summative exam results of cycles I and II, the attainment of KKTP was analyzed. Table 3 displays the KKTP accomplishment %.

**Table 3.** The proportion of students who achieved the KKTP of mathematics learning outcomes

	Base Score	Summative Test I	Summative Test II
The quantity of students who reach KKTP ( $\geq 75$ )	6	11	22
The proportion of pupils that reach KKTP (%)	25%	45,83%	91,66%

The information in Table 2 demonstrates that students' KKTP accomplishment was still rather low in the early phases (pre-cycle), with just 6 students, or around 25% of the total number of students, meeting the KKTP criteria of completion. Following the implementation of the PBL model, cycle I saw an increase of 20.83%, with 11 students, or 45.83% of the total number of students, successfully achieving a score of  $\geq 75$ . Additionally, there were 22 learners who attained KKTP in cycle II, which is about 91.66% of the total number of learners and a 43.83% increase over cycle I. This indicates that more students have attained KKTP as a result of the PBL model's implementation. This demonstrates how the PBL model's implementation enhances students' learning results in mathematics. As a result, the PBL model's activities were successful in raising the proportion of students who achieved KKTP in each cycle as well as their overall number.

The frequency distribution of students' results, as displayed in Table 4, further supports the examination of learning outcomes.

**Table 4.** Frequency Distribution of Students' Learning Outcomes in Mathematics

Value Interval	Predicate	Frequency of Learners		
		Base Score	Summative Test I	Summative Test II
0 – 40	beginning to develop	1	2	1
41 – 65	feasible	9	9	2
66 – 85	proficient	14	13	13
86 – 100	advanced	-	-	8

According to the statistics, the distribution of learning outcomes changes once PBL is implemented, becoming more uniformly distributed and producing higher value categories. There were fewer students who had previously fallen into the "beginning to develop" (0–40) and "feasible" (41–65) low score ranges. On the other hand, the proportion of students who achieved the "proficient" (66–85) and "advanced" (86–100) categories rose.

Based on the explanation of the analysis of the learning outcomes improvement, it can be said that both the learning process and the attainment of students' learning outcomes in mathematics improved. These findings support the theory that students in class IX.3 SMP Babussalam Pekanbaru improve their learning outcomes in mathematics while using the PBL learning paradigm. This is consistent with a study by Irka and Jamaan (2023) that found PBL can encourage students to participate in the learning process. Pratama (2024) provides more support, explaining that this approach aids students in discovering ideas through an exploration process based on challenges presented from the start of the learning process. In the even semester of the 2024–2025 academic year, it has been demonstrated that using the PBL approach may enhance students' learning results in mathematics on SPLDV content. The reason for this improvement is that PBL encourages active learning, in which students work to find meaningful and pertinent solutions to real-world situations. Students gain problem-solving, teamwork, and critical thinking abilities through this process. PBL also promotes independence and accountability for learning, which results in a deeper comprehension and longer-term memory of mathematical ideas.

## CONCLUSIONS AND RECOMMENDATIONS

The findings of this study indicate that the Problem-Based Learning (PBL) approach can effectively improve students' mathematics learning outcomes. This improvement is reflected in the increase in the percentage of students achieving the expected learning mastery, which rose from 25% in the initial condition to 45.83% in Cycle I and further increased to 91.66% in Cycle II. The consistent improvement across cycles demonstrates that PBL supports students in understanding mathematical concepts and solving problems more effectively, particularly in

learning the system of linear equations in two variables in accordance with the learning objectives for Phase D.

Furthermore, the results suggest that PBL can serve as an engaging instructional alternative by presenting mathematical concepts through contextual, real-world problems that help students relate learning content to their everyday experiences. The role of the teacher as an active facilitator is crucial in guiding students throughout the problem-solving process. Effective facilitation, along with appropriate supervision and time management, ensures that each phase of the PBL process is implemented optimally and aligned with the objectives outlined in the teaching module. Overall, the findings confirm the potential of PBL as an effective approach for improving students' mathematics learning outcomes in classroom practice.

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