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Implementation of Problem-Based Learning Model to Improve Mathematics Learning Outcomes at SMP Muhammadiyah 1 Pekanbaru

Yona Fathiyyah Veonansa[1], Maimunah[2*], Rini Dian Anggraini[3]
[1,2,3] Mathematics Education, Faculty of Education, Universitas Riau, 28293, Indonesia
Email of Authors: yona.fathiyyah5583@student.unri.ac.id, maimunah@lecturer.unri.ac.id, rinidian.anggraini@lecturer.unri.ac.id

Abstract
This study was motivated by the low mathematics learning outcomes of class VII.3 students at SMP Muhammadiyah 1 Pekanbaru on the topic of Algebraic Expressions, where only 9 out of 26 students (34.62%) achieved the Learning Objectives Achievement Criteria. The learning process had not yet followed the stages of the Problem-Based Learning (PBL) model, which is expected to enhance students' engagement and learning outcomes. Therefore, this study aimed to improve the learning process and enhance students' mathematics learning outcomes through the implementation of the PBL model. This study employed a collaborative Classroom Action Research (CAR) approach conducted over two cycles. Each cycle consisted of the stages of planning, action implementation, observation, and reflection. The research subjects were 26 Grade VII.3 students of SMP Muhammadiyah 1 Pekanbaru in the 2025/2026 academic year. The data collection instruments included observation sheets for teacher and student activities, as well as learning achievement tests. The findings revealed that the implementation of the PBL model had a positive impact on both student and teacher engagement during the learning process. The percentage of students who achieved the KKTP increased from 34.62% in the pre-cycle to 46.15% in Cycle I and 73,08% in Cycle II. Thus, the implementation of the PBL model was proven to improve the learning process and enhance students' mathematics learning outcomes. This model is recommended as an effective approach to improving the quality of mathematics instruction at the secondary school level.

Keyword: Problem Based Learning (PBL), Mathematics learning outcomes, Classroom Action Research

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* Corresponding author

Introduction
Mathematics is a science or field of knowledge that examines logical thinking processes as a foundation for development and plays an important role in human life (Mulyati, 2020:64). Mathematics is not only studied to be mastered conceptually, but also as a means of developing understanding, training thinking skills, and solving various problems in daily life. The Decree of the Head of the Curriculum and Education Assessment Standards Agency (SK Kepala BSKAP) (2025:133) states that learning

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mathematics can improve students' ability to think logically, analytically, systematically, critically, and creatively, in accordance with the characteristics of mathematics learning as a mental activity that shapes patterns of thinking and understanding capable of developing various competencies. Learning mathematics can be understood as a meaningful learning process that involves logical, critical, and structured thinking to improve students' ability to achieve learning objectives.

The objectives of mathematics learning outlined in SK Kepala BSKAP No. 046 of 2025 emphasize critical, creative, and systematic thinking through contextual, applicable, and problem-based learning. In this study, these objectives are relevant to congruence and similarity because students work with contextual situations that require them to interpret information, represent relationships geometrically, and communicate mathematical reasoning. Thus, learning outcomes are used as an indicator of whether the learning process supports students in engaging with contextual mathematical problems (Agustin, Rahaju, & Hidayat, 2023:109; Rahmawati et al., 2020:375).

The completeness of learning outcomes is regulated through Ministerial Regulation (Permendikbudristek) No. 21 of 2022 concerning Education Assessment Standards. Mathematics learning outcomes can be measured using the Learning Objectives Achievement Criteria (KKTP). KKTP serves as a reference for assessing the achievement of learning objectives in summative assessments, providing information on that achievement; in other words, whether or not KKTP is achieved is determined through analysis of the results of the summative assessments carried out by students. Summative assessment is a process carried out to ensure the overall achievement of learning objectives (Permendikbud No. 21 of 2022).

Based on data obtained from the mathematics teacher of class VII.3 at SMP Muhammadiyah 1 Pekanbaru, it is known that the KKTP set by the school for grade VII mathematics is 75. The percentage of KKTP achievement data from the summative assessment of the 26 students of class VII.3 at SMP Muhammadiyah 1 Pekanbaru in the odd semester of the 2025/2026 academic year can be seen in Table 1.

Table 1. Percentage of KKTP Achievement in Summative Assessment

Main Topic	Number of Students Achieving KKTP	Percentage of Students Achieving KKTP
Ratio	10	38.46%
Algebraic Expressions	9	34.62%

The data in Table 1 show that the percentage of students achieving KKTP is relatively low, as it remains below 50%, resulting in a discrepancy with the expected mathematics learning outcomes, since learning outcomes reflect the implementation of the learning process. There are many factors contributing to the low mathematics learning outcomes, one of which lies in the learning process itself.

The results of interviews with the teacher and students indicate that the low learning outcomes are influenced by low student participation in the learning process, causing the learning to remain teacher-centered; the perception that mathematics is a difficult subject, which reduces learning motivation; students' inability to solve word problems due to insufficient understanding of solution steps and difficulty interpreting problems; a lack of understanding of basic concepts causing students difficulty in solving contextual problems; and the fact that a learning model capable of encouraging students' active involvement had not yet been implemented. Observation results also show that the learning process remains teacher-centered and does not yet fully reflect an interactive,

inspiring, enjoyable, and challenging learning atmosphere, as mandated by Ministerial Regulation (Permendikbud) No. 16 of 2022 concerning Process Standards.

Efforts to improve the learning process can be made through the selection of an appropriate learning model (Arianty, 2025:2182). This is in line with the opinion of Nada et al. (2024:233), who emphasizes the importance of selecting a suitable learning model so that students are more interested and find it easier to understand the material, making the learning process more effective. A learning model considered capable of improving the learning process while also providing students the opportunity to enhance their mathematical communication skills through contextual problems relevant to students' lives is the Problem Based Learning model (Madhavia et al., 2020:1241).

Through the PBL model, teachers raise problems relevant to students so that students can participate actively in learning and gain a more realistic learning experience (Singgih, 2025:50). PBL is a student-centered learning model that emphasizes active involvement in solving real or contextual problems. The PBL learning model has various advantages that support the creation of active and meaningful learning. PBL encourages students to be actively involved in an enjoyable learning atmosphere, while also training critical thinking skills through solving real problems relevant to daily life. In addition, PBL helps students apply their existing knowledge and build learning independence, as students become accustomed to seeking solutions and information independently (Rubianti et al., 2019:85).

Previous studies provide evidence that PBL can support mathematics learning, but they differ in context and emphasis. Lestari (2020) examined PBL for algebraic expressions in Grade VII and reported an increase in learning outcomes from Cycle I to Cycle II, while noting that the student worksheets were monotonous and some problems were not contextual. Sauduran (2022) compared PBL with conventional learning and reported higher mathematics achievement for the PBL group. Rahmawati et al. (2020) also reported improvement in mathematics learning outcomes through PBL. Taken together, these studies support the use of PBL, but the cited studies do not specifically describe students' adaptation to PBL when working with contextual geometric problems on congruence and similarity. The present study addresses this classroom-level gap by documenting changes in students' participation, collaboration, presentation, and problem-solving behavior across two PBL cycles in a congruence and similarity context.

Based on the problems identified in class VII.3 at SMP Muhammadiyah 1 Pekanbaru, this study was designed as classroom action research to improve the learning process and mathematics learning outcomes through PBL. The study focuses on congruence and similarity and specifically examines how students' participation and problem-solving behavior develop as they become familiar with the PBL stages. The research question is whether implementation of PBL can improve the learning process and mathematics learning outcomes of class VII.3 students on congruence and similarity during the even semester of the 2025/2026 academic year.

Method

This study was conducted at SMP Muhammadiyah 1 Pekanbaru, specifically in class VII.3, during the even semester of the 2025/2026 academic year. This study is a type of classroom action research (CAR) using a collaborative approach, in which the researcher worked together with the mathematics teacher. In its implementation, the researcher acted as the implementer of the action, while the class mathematics teacher acted as an observer during the learning process. This collaboration was intended to ensure that the implementation of the action in the study could run more effectively.

The research was conducted over two cycles. Each cycle consisted of four stages: planning, action implementation, observation, and reflection. These stages were designed to support gradual improvement in the learning process and student learning outcomes. The subjects of this study were all 26 students of class VII.3 at SMP Muhammadiyah 1 Pekanbaru. Students in this class had heterogeneous academic ability backgrounds. The study targeted improvement in students' mathematics learning outcomes and learning activity through the implementation of the Problem Based Learning (PBL) model.

The procedure of this study comprised four stages. First, the planning stage involved developing learning tools, such as the Learning Objectives Flow (ATP) and lesson plans designed based on learning outcomes within the Merdeka Curriculum. In addition, data collection instruments were prepared, including observation sheets for teacher and student activities, as well as learning achievement test questions. The formation of study groups was also carried out at this stage, taking into account student heterogeneity based on previous test results.

The second stage was action implementation. At this stage, the researcher taught using the PBL learning model that had been designed. Each cycle consisted of two learning sessions and one summative assessment. The learning process followed the syntax of the PBL model, which consists of several phases, from problem orientation to evaluation of problem-solving.

The third stage was observation. Observation was carried out by the class teacher as an observer to assess the implementation of the researcher's and students' activities during the learning process. The observation covered the entire learning process, from beginning to end, and the results were recorded on the prepared observation sheets.

The final stage was reflection. Reflection was carried out jointly by the researcher and the teacher after each learning cycle was completed. The observation results were analyzed to evaluate the success of the action and to identify any obstacles or shortcomings that still occurred. The reflection results were used as the basis for improvements in the implementation of the next cycle.

The instruments used in this study consisted of two types: learning tools and data collection instruments. The learning tools included the ATP and lesson plans developed in accordance with the structure of the Merdeka Curriculum. The lesson plans included important components such as learning objectives, meaningful understanding, guiding questions, learning activities, as well as formative and summative assessments.

The data collection instruments consisted of observation sheets for teacher and student activities, as well as mathematics learning achievement tests. The tests were developed based on test specification grids aligned with the learning objectives and accompanied by alternative solutions. Observation data were used to determine student and teacher engagement in learning, while mathematics learning achievement test data were used to determine the improvement in students' understanding of the material.

Data collection techniques in this study were carried out through observation, mathematics learning achievement tests, and documentation. Observation was carried out to observe the learning process and record teacher and student activities. Learning achievement tests were given after each cycle to determine the improvement in student learning outcomes. Documentation was used to complement the data, such as photographs of activities and student work.

Data analysis techniques were carried out by calculating the percentage of implementation of teacher and student activities during learning, as well as calculating the percentage of learning outcome completeness based on the Learning Objectives Achievement Criteria (KKTP). In addition, qualitative analysis was also used during the reflection stage to assess emerging obstacles and determine improvement steps for the next cycle.

The study has several methodological limitations. It involved one intact class of 26 students and had no comparison group. The researcher implemented the action, while the class teacher served as observer, so researcher and observer judgments may still be subject to bias. The manuscript does not report a formal expert content-validity assessment, a reliability coefficient for the achievement test, or an inter-rater reliability coefficient for the observation sheets. Individual paired raw scores were also not included in the manuscript; therefore, an inferential paired comparison cannot be calculated from the reported frequency data alone. The quantitative results are consequently interpreted descriptively, and causal claims are avoided.

Thus, this research method was systematically designed to provide a comprehensive picture of the learning process and its improvement through the implementation of the Problem Based Learning model, in order to enhance the mathematics learning outcomes of class VII.3 students at SMP Muhammadiyah 1 Pekanbaru.

Result and Discussion

This study aimed to improve the learning process and enhance students' mathematics learning outcomes through the implementation of the Problem Based Learning (PBL) model. The action was implemented over two cycles, each consisting of two sessions and concluded with one summative assessment. The data analyzed included teacher and student activities during the learning process, as well as mathematics learning achievement measured through the summative test.

Student learning success was analyzed quantitatively using the Learning Objectives Achievement Criteria (KKTP) set by the school, namely a minimum score of ≥ 75. The assessment was conducted by comparing students' mathematics learning outcomes before and after the implementation of the action, through the baseline score, Summative Test I (after Cycle I), and Summative Test II (after Cycle II). A detailed analysis of student learning outcomes before and after the learning action can be seen in Table 2.

Table 2. Percentage of Students Achieving KKTP

	Baseline Score	Summative Test 1	Summative Test 2
Number of Students Achieving KKTP (≥ 75)	9	12	19
Percentage of Students Achieving KKTP (%)	34.62%	46.15%	73.08%

Based on Table 2, 9 of the 26 students (34.62%) achieved the KKTP at baseline. After Cycle I, the number increased to 12 students (46.15%), and after Cycle II it increased to 19 students (73.08%). These percentages are internally consistent with the reported counts: 9/26 = 34.62%, 12/26 = 46.15%, and 19/26 = 73.08%. The Cycle I value should therefore be reported consistently as 12 students and 46.15% throughout the manuscript, subject to confirmation against the original raw scores.

Table 3. Frequency Distribution of Students Mathematics Learning Outcomes

Interval	Kriteria	Student Frequency		
		Baseline Score	Summative Test 1	Summative Test 2
92 ≤ x ≤ 100	Advanced	0	2	8

83 ≤ x < 92	Proficient	2	5	7
75 ≤ x < 83	Competent	7	5	4
< 75	Developing	17	14	7

This improvement is also reflected in the distribution of student proficiency categories based on score intervals. For example, at baseline no students achieved the "advanced" category, which then gradually increased to 8 students (30.76%) by the end of Cycle II. The number of students still in the "developing" category decreased sharply from 17 students (65.38%) to only 7 students (26.92%). An example of a student's response in the "advanced" category is presented in Figure 1.

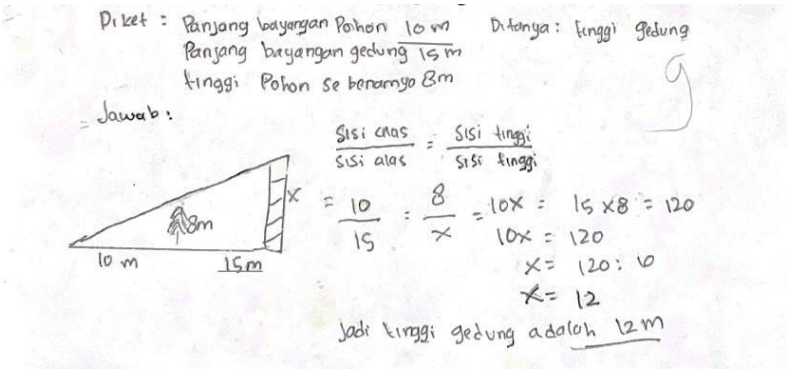


Figure 1. Example of a student's Response in The Advanced Category

The student's response demonstrates the ability to apply the concept of similar triangles to solve a contextual problem involving the height of a building. The student identified the relevant information, represented the situation geometrically, and established a proportional relationship between the height and shadow lengths of the tree and the building. The relationship can be written as $\frac{10}{15}=\frac{8}{x}$. Therefore, 10x = 8 × 15 = 120, so x = 12 m. This solution indicates that the student was able to understand the problem, select an appropriate mathematical concept, and apply a problem-solving strategy to arrive at a correct solution. From the perspective of PBL, the response shows how contextual problems can require mathematical representation and application of a geometric concept. Although the final answer was correct, the presentation of the mathematical steps could be made more systematic and mathematically precise.

The results indicate an association between implementation of PBL and improvement in student participation and mathematics learning outcomes in this classroom. However, the increase should be interpreted cautiously because the study used one intact class without a comparison group. The improvement may reflect a combination of continued PBL implementation, repeated practice, students' increasing familiarity with the learning routines, and instructional adjustments made between cycles.

Table 4. Analysis of Teacher and Student Activities

PBL Phase	Cycle I	Cycle II
Phase 1: Orienting Students to the Problem	The researcher guided students to read and understand the problems in the student worksheets (LKM). Many	Students had begun to become familiar with the process and were able to follow the researcher's instructions to

	students still appeared unfamiliar with completing the LKM and therefore required guidance from the researcher.	read and understand the problems in the LKM properly. Their performance improved progressively in each meeting.
Phase 2: Organizing Students for Learning	During the first and second meetings, students still appeared confused when identifying the problems. The researcher also had to provide assistance.	From the third to the fourth meeting, students had become more accustomed to identifying problems. The number of students who actively expressed their opinions also increased.
Phase 3: Guiding Individual and Group Investigation	During the first meeting, the researcher still experienced difficulties in guiding the discussion because students tended to work individually and were not yet accustomed to working in groups. In the following meetings, students became more active in interacting within their groups.	Students had begun to become accustomed to working collaboratively in their groups. The researcher moved around the classroom to monitor the results of group discussions and provide assistance with difficulties encountered by the students.
Phase 4: Developing and Presenting the Work	The researcher instructed students to prepare reports of their group discussions and present them. Students were observed discussing the preparation of their group discussion reports. During the first meeting, the researcher had to select a group representative to present the discussion results. However, many students were reluctant to present because they lacked confidence, and no group was willing to respond to the presentation.	The researcher instructed students to prepare reports of their group discussions and present them. During the third and fourth meetings, students became more confident and volunteered to present the results of their group discussions. Some students also began to feel confident enough to comment on their peers' answers. The number of students providing comments also increased and varied.
Phase 5: Analyzing and Evaluating the Problem-Solving Process	The researcher asked students about the problem-solving process they had carried out. Students were still unfamiliar with solving problems by following the stages of PBL.	The researcher asked students about the problem-solving process they had carried out. Students had begun to become accustomed to solving problems by following the stages of PBL.

The activity observations help explain why participation was stronger in Cycle II. In Cycle I, students were still adapting to the PBL stages: they required guidance to read and

interpret contextual problems, were uncertain when identifying problems, tended to work individually, and were hesitant to present or respond to group work. In Cycle II, students were more familiar with the LKM and PBL sequence, participated more actively in identifying problems and expressing opinions, collaborated more consistently, and became more willing to present and comment on peers' work. The reflection between cycles also led to more contextual guiding questions and more effective facilitation of group activities. Thus, the stronger performance in Cycle II is plausibly related to both continued PBL implementation and students' growing familiarity with the procedures and teacher adjustments. Because there was no comparison group and no inferential paired test based on individual raw scores, the study cannot determine that PBL alone caused the observed improvement.

Improvement began to emerge in Cycle II. Students had become accustomed to following the instructions for understanding the problems and were better able to identify them. Their participation in expressing opinions also increased. In the individual and group investigation phase, students who tended to work individually in Cycle I began to demonstrate the ability to collaborate and interact within their groups in Cycle II. This indicates that students became increasingly actively involved in group discussions and problem-solving activities.

An increase in activity was also observed in the phase of developing and presenting the work. In Cycle I, students were still hesitant to present their discussion results and few groups were willing to respond to the presentations. In Cycle II, students became more confident in volunteering to present their group discussion results and commenting on their peers' answers. The increasing number of students providing responses indicates greater participation and confidence in communicating during the learning process.

Furthermore, in the phase of analyzing and evaluating the problem-solving process, students in Cycle I were still unfamiliar with solving problems according to the PBL stages. In Cycle II, students began to become accustomed to following the PBL steps in solving problems. Thus, students' learning activities developed from initially requiring substantial guidance to becoming more independent in participating in problem-based learning activities.

Overall, Cycle II showed better development of student participation than Cycle I, particularly in understanding and identifying problems, collaborating in groups, presenting discussion results, and responding to peers. These changes are relevant to the contextual and collaborative problem-solving activities used in the congruence and similarity lessons.

The improvement in learning outcomes achieved was not only reflected in cognitive achievement through increased summative test scores, but was also evident in students' affective and social aspects. Students showed increased enthusiasm in asking questions, discussing, and expressing ideas during the learning process. These findings reinforce the results of Rahmawati et al. (2020), which showed that the PBL model contributes to improved conceptual understanding and active student participation in learning.

In addition, reflections conducted between cycles showed that the teacher also experienced improvement in managing learning that was more interactive and student-centered. Learning strategies were continuously refined, including through the use of more contextual guiding questions and improved effectiveness in facilitating group activities.

Taken together, the qualitative observations and descriptive changes in KKTP achievement indicate improvement during the two-cycle intervention. Nevertheless, the findings should be understood as classroom-level evidence of improvement rather than definitive causal evidence of PBL effectiveness.

Conclusion

Based on the research conducted in class VII.3 at SMP Muhammadiyah 1 Pekanbaru, implementation of the Problem Based Learning (PBL) model was followed by improvement in the learning process and students' mathematics learning outcomes on congruence and similarity. Student participation developed across the two cycles: students became more accustomed to identifying contextual problems, collaborating in groups, presenting their work, responding to peers, and following the PBL problem-solving stages. The proportion of students achieving the KKTP increased from 34.62% at baseline (9 of 26 students) to 46.15% after Cycle I (12 of 26 students) and 73.08% after Cycle II (19 of 26 students).

The findings are most directly applicable to this class and topic. The improvement in Cycle II coincided with students' greater familiarity with PBL routines and instructional adjustments after Cycle I, so the increase cannot be attributed to PBL alone. The study is limited by its single-class design, absence of a comparison group, lack of reported formal instrument validation, and absence of inferential analysis based on individual paired raw scores. For similar Grade VII mathematics settings, contextual congruence and similarity problems within PBL may be accompanied by stronger initial scaffolding for problem interpretation, group collaboration, and presentation, which were the areas that developed most visibly across the cycles.

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