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Implementation of Problem Based Learning to Improve Students' Mathematics Learning Outcomes at UPT SMP Negeri 10 Tapung

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A B S T R A C T

The success of students in learning mathematics cannot be separated from the mathematics learning process at school. In the learning process at school, improving learning outcomes is very necessary in order to obtain complete learning outcomes. Therefore, teachers must be able to apply learning models that can create a learning atmosphere that attracts students' attention, can train students' way of thinking to understand mathematical concepts and can play an active role in the learning process. So, teachers need to apply the Problem Based Learning (PBL) model to improve student activity and student learning outcomes. PBL helps students gather information, build new knowledge, and develop the skills needed for active and independent learning. The purpose of the study was to improve student learning outcomes. Data were collected through observation, tests, and documentation. Based on the results of the research that the researcher has conducted, it can be concluded that the application of the PBL model can improve the learning process and can improve the mathematics learning outcomes of class VIIIC students of UPT SMP Negeri 10 Tapung in the even semester of the 2024/2025 academic year on the material of the Two Variable Linear Equation System.

1. Introduction

Learning can be interpreted as an effort to change behavior. Learning can also be defined as a process of change that occurs in students to acquire new knowledge, from initial ignorance to knowledge. According to Rosnawati (2020), learning is an activity carried out intentionally or unintentionally by each individual, resulting in changes in knowledge. Learning is the process of changing the formation of a person's behavior and the process of understanding knowledge, skills, and values, both in society and education (Rochmania, 2022). Learning outcomes are changes in behavior from initially not knowing to knowing and from not understanding to understanding (Warti, 2016; Ingram, 2020; Merke, 2024). Learning outcomes are abilities acquired by students after receiving learning experiences from teachers or educators. Learning outcomes play an important role in the learning process because with these results, teachers can determine how the experience or knowledge that has been obtained by students in an

effort to achieve learning objectives through the subsequent teaching and learning process (Wibowo, 2021). Mathematics learning outcomes according to Widyaningrum (2022) are a form of student ability to solve problems using mathematics. Mathematics learning outcomes are the degree of success achieved by students in mastering mathematics after gaining experience in learning within a specific curriculum (Busran, 2021).

Based on Permendikbudriset No. 12 of 2024, the independent curriculum is designed with learning categories that emphasize student learning progress and are derived from the KKTP, which lead to reflection on student learning progress carried out collaboratively with students. In implementing learning aimed at improving the outcomes stated in Permendikbudriset No. 16 of 2022 Article 9, which is designed to provide a quality, interactive, and contextual learning experience, teachers are encouraged to provide learning that is: (1) interactive, (2) inspiring, (3) enjoyable, (4) challenging, (5) motivating students to be active, and (6) providing sufficient space for creativity and independence according to students' talents, interests, and physical and psychological development. The success of students in learning mathematics is inseparable from the mathematics learning process at school. In the learning process at school, improving learning outcomes is essential to achieving complete learning outcomes.

Therefore, teachers must be able to apply learning models that can create a learning atmosphere that attracts students' attention, can train students' way of thinking to understand mathematical concepts and can play an active role in the learning process (Zosh et al., 2024; Firdaus et al., 2021). Studying mathematics also improves numeracy skills, understanding patterns and structures and problem solving. In Permindikbudriset No. 21 of 2022 Article 9 paragraph (8) states that the assessment of student learning outcomes is carried out by comparing student learning outcomes with the KKTP. These mathematics learning outcomes can be seen after students follow the learning process in class with the provisions of the KKTP. High learning outcomes are important because they indicate the achievement of educational goals and provide benefits for individuals and can increase learning motivation, broaden knowledge and insight and open wider opportunities in the future.

Based on Permindikbudriset No. 12 of 2024, the independent curriculum is designed with learning categories that emphasize student learning progress and are derived from the KKTP, which lead to reflection on student learning progress carried out collaboratively with students. This data was obtained from the summative scores of 31 class VIIIC students at UPT SMPN 10 Tapung. The number of students who achieved the KKTP in the summative was 12 out of 31 students. This can be seen in the KKTP achievement percentage of Class VIIIc students at UPT SMPN 10 Tapung for the Power Numbers material, which had a KKTP achievement percentage of 48.37% and the Pythagorean Theorem material, which had a KKTP achievement percentage of 38.70%. This indicates that many students have not achieved the KKTP indicators. Based on interviews with three students, it was discovered that the teacher's monotonous and unengaging teaching methods caused students to not understand the material, feel bored, and are reluctant to ask questions due to embarrassment and fear of being scolded.

Researchers conducted interviews with mathematics teachers at UPT SMPN 10 Tapung to determine student activities during the mathematics learning process. Based on interviews with mathematics teachers, several factors were obtained that caused low student learning outcomes, namely 1) Only a few students were active in the learning process such as asking and answering questions; 2) Lack of interaction between teachers and students so that students still depended on teacher explanations; 3) Students did not dare to ask the teacher if they felt they did not understand; 4) Students' understanding of the material was lacking so that some students only copied answers from their friends and many students had difficulty working on contextual questions.

By implementing a learning model, teachers can create a pleasant learning environment, thereby improve the learning process and enhance student learning outcomes. Ministerial Regulation No. 16 of 2022 explains that improving student learning outcomes is achieved through learning strategies designed to provide quality experiences. One model that actively engages students and provides opportunities for them to understand concepts is the Problem-Based Learning (PBL) model. The Problem-Based Learning model has several unique characteristics inherent in its process and implementation (Syamsidah, 2018): (1) student-centered learning, (2) learning occurs in small groups of students, (3) the teacher acts as a facilitator, (4) problems serve as the focus and stimulus for learning, (5) problems develop problem-solving skills, and (6) information is obtained through self-directed learning. The stages of the Problem-Based Learning model consist of five main stages. These steps refer to the steps regarding PBL learning activities which include providing orientation to students, organizing students

to research, guiding student investigations, developing and presenting results as well as analyzing and evaluating the problem-solving process (Arends in Suherti, 2018). The PBL stages consist of five main stages, namely: student orientation to the problem, organizing or directing student learning, guiding students, creating and presenting work, conducting analysis and evaluating problems (Rusmono, 2017).

According to research conducted by Vanny Yuniawardani and Mawardi (2018), Problem-Based Learning is significantly related to mathematics learning outcomes and can improve students' mathematical problem-solving abilities. Another relevant study is Saryantono's (2013) study at Adiguna High School in Bandar Lampung, which stated that there is a significant influence of Problem-Based Learning (PBL) on student motivation and learning outcomes, as evidenced by improved student learning outcomes. Based on the problems outlined above, the researchers conducted a study using a problem-based learning model to improve the learning process and mathematics learning outcomes of class VIIIc students at UPT SMP Negeri 10 Tapung in the 2024/2025 academic year on the topic of Two-Variable Linear Equation Systems. The researchers attempted to implement this learning model in the hope of improving the learning process and improving student learning outcomes on the topic of Two-Variable Linear Equation Systems.

2. Methodology

This research was conducted in class VIIIc of UPT SMP Negeri 10 Tapung in the 2024/2025 academic year, even semester. The subjects of this research were 31 class VIIIc students with heterogeneous ability levels. The type of research conducted was Classroom Action Research (CAR). According to Kumwichar (2023), classroom action research is action research carried out in the classroom. The application of facts found to solve problems in social situations and to improve the quality of actions carried out by involving collaboration and cooperation between researchers and practitioners (Fazel, 2025). This research was conducted collaboratively, where researchers, mathematics teachers of class VIIIc of UPT SMP Negeri 10 Tapung, and mathematics education students collaborated in the process of implementing the action. In the learning process, the Problem Based Learning (PBL) model will be implemented so that students are more creative and actively involved in the thinking process and learning activities. The implementation of the action will be carried out by the researcher himself (as a teacher), the subject teacher as an observer of the researcher's activities (as a teacher) and mathematics education students as observers of student activities during the learning process in class VIIIC SMPN 10 Tapung. This research consists of two cycles with four stages, namely the first stage the researcher plans the actions to be implemented, namely creating a Learning Objective Flow and Data Collection Instruments for four meetings, observation sheets and student learning outcome tests. The second and third stages are carried out simultaneously, namely the implementation of actions and observations, the last stage is reflection. Data collection instruments consist of observation sheets and learning outcome tests (Sudjana, 2016).

Qualitative data was obtained from teacher and student observation sheets. The analysis technique used descriptive narrative analysis, with the aim of illustrating the learning process and writing it in narrative form. Data obtained through observations of teacher and student activities and student mathematics learning achievement tests were then analyzed. Data analysis of teacher and student activities aimed to determine the implementation of each phase of the PBL model and to identify strengths and weaknesses in the learning process. These weaknesses can be addressed in the next meeting. Indicator achievement was calculated for each indicator; students achieved an indicator if they scored at least 73. The criteria for successful action in this study included:

1. Improvement in the learning process, as indicated by the alignment of teacher and student activities with the planned PBL steps.
2. Improvement in student learning outcomes, as seen from the analysis of the achievement of the KKTP indicators.

3. Results and Discussion

The analysis of student learning outcomes data consisted of an analysis of the achievement of the KKTP indicators.

Analysis of KKTP Indicator Achievement

Students' mathematics learning outcomes were analyzed individually. Students were deemed to have achieved the KKTP indicator achievement set by the school, which was 73. Based on the summative scores in Cycles I and II, it can be seen that some students still did not achieve the indicators in Cycle I and II. To determine whether there was an improvement in student learning outcomes before and after the intervention, see the following table.

Table 1. Percentage of KKTP Indicator Achievement

Learning outcomes	Before Action	After Action	
	Base Score	Daily Test I	Daily Test II
Number of students who achieved the KKTP indicator achievement (≥ **73**)	6	18	20
Percentage of students who achieved the KKTP indicator achievement	19,35%	58,06%	64,51%

Based on Table 1, it can be seen that the number of students who achieved the KKTP indicator achievement in Summative 1 increased by 12 students from the basic score with a percentage increase of 38.71%. In Summative 2, the number of students who achieved the KKTP indicator increased by 2 students from Summative 1 with an increase of 6.45%. From these data, it can be concluded that the number of students who achieved the KKTP indicator from the basic score (before the action) to the Summative score -1 (after the action) and the number of students who achieved the KKTP indicator from Summative 1 to Summative 2 (after the action) has increased.

Analysis of KKTP Indicator Achievement

Based on the mathematics learning outcome scores obtained from the KKTP achievement for each indicator, in the first and second cycles of the Summative Cycle, the number of students who achieved the completion criteria for each indicator can be determined, is shown in Table 2.

Table 2. Percentage of KKTP Achievement for Indicators in Cycle I

No	Achievement Indicators	Number of Students Reaching KKTP Indicator	Percentage (%)
1	Explaining the concept of SPLDV and solving SPLDV using the Elimination method	18	60%
2	Solving SPLDV with the Substitution Method	20	65%

Students' mathematics learning outcomes are analyzed individually for each indicator based on their scores in Summative 1 and Summative 2, which can be seen from the number of students who achieved the KKTP for each indicator. The number of students who achieved the KKTP for each indicator (achieving a score of ≥73 for each indicator).

The number of students who achieved the KKTP for each indicator in Summative 2 can be seen in Table 3. In the Table 3, the percentage of achievement of the KKTP indicators in Cycle II was better than that in Cycle I. This indicates an improvement in Cycle II. The number of students achieving the KKTP for Indicator 1 was 24, representing 80% achievement, and for Indicator 2, 26 students achieved 85%. KKTP achievement indicators for the System of Linear Equations in Two Variables (SPLDV) material

Table 3. Percentage of KKTP Achievement in Cycle II

No	Achievement Indicators	Number of Students Reaching KKM Indicator	Percentage (%)
1	Solving SPLDV with Mixed Methods	24	80%
2	Solving SPLDV with Graphical Method	26	85%

a. Students can explain the concept of a system of linear equations in two variables. Students can determine the solution to a system of linear equations in two variables using the elimination method.

The analysis obtained from the results of the student test in explaining the concept of the Two Variable Linear Equation System shows that 20% of students can apply it correctly and for the student test in determining the solution of the Two Variable Linear Equation System using the elimination method, most students have not been able to complete the formative test given correctly and completely. The evaluation of its achievement has not yet reached the set criteria. The drawback is that students still have difficulty in applying the concept of the Two Variable Linear Equation System in more complex problems and the implementation of the elimination method in formative I has not been as expected. Recommendations for improvement are that researchers can provide more exercises and examples to improve students' mathematics learning outcomes.

b. Students can determine the solution to a system of linear equations with two variables using the substitution method.

The analysis obtained from the students' test results in determining the solution of the Two-Variable Linear Equation System using the substitution method in the formative test given was better than the previous meeting. Increasingly, students' learning outcomes are improving. Evaluation of achievement shows that some children have reached the set criteria. However, many students still score below the achievement criteria, although their scores have improved from the previous results. The drawback is that some students still do not understand the process of solving problems correctly and completely. There are some students who only do the work correctly but not completely. The researcher's improvement is to provide direction for future learning objectives so that the expected results are better.

c. Students can determine the solution to a system of linear equations with two variables using the mixed method.

The student test results showed that 80% of students were able to determine the solution to the System of Linear Equations in Two Variables using the mixed method. 85% of students were able to answer the formative test correctly and completely. The expected achievement criteria for some students had been achieved. The weakness in this case was that for low-ability students, some students still had difficulty completing the formative test correctly and completely. The improvements made by the researcher were to focus on students who had difficulty understanding the questions given to improve the expected learning outcomes.

d. Students can determine the solution to a system of linear equations with two variables using the graphical method.

Analysis of students' test results in solving systems of linear equations in two variables using the graphical method shows improvement and improvement. Almost all students were able to answer correctly and completely. The weakness in this case is that students with low abilities have improved and improved compared to the previous test, but they have not yet reached the expected criteria. The researcher's improvement is to provide exercises to improve mathematics learning outcomes.

Frequency Distribution

The frequency distribution analysis of students' mathematics learning outcomes for the topic "Systems of Linear Equations in Two Variables" is presented in Table 4 below. Table 4 Frequency Distribution of Students' Mathematics Learning Outcomes

Table 4. Frequency Distribution of Students' Mathematics Learning Outcomes

Value Interval	Predicate	Student Frequency		
		Base Score	Summative Test I	Summative Test II
$X < 73$	Low	25	13	11
$73 \leq X < 82$	Medium	2	12	4
$82 \leq X < 91$	Hight	4	5	10
$91 \leq X < 100$	Very Hight	0	1	6

Based on Table 4, it can be seen that the frequency distribution of students is divided into three assessments, namely basic scores, summative test I, and summative test II. In general, it can be observed that the majority of students have a low basic score, namely 25 students who have not reached the mathematics achievement indicator. This indicates that the majority of students start with a basic level of understanding that is not optimal. However, in summative test I, the frequency distribution of students shows improvement with the number of students in the Medium and High categories being more evenly distributed compared to the basic score, although there are still 13 students in the Low category.

The improvement in learning outcomes is increasingly visible in summative test II where the number of students in the High and Very High categories increased significantly. And for the Low and Medium categories decreased compared to Summative Test I. This indicates a positive learning process in most students over time through the learning and evaluation process. From the analysis of table 4, it is said that there has been an increase in students' mathematics learning outcomes. Based on this, the analysis of success in the material of the System of Linear Equations of Two Variables showed an increase in the average basic score of 19.35% to Summative Test I to 58.06% and to Summative Test II to 64.51%. This

indicates an improvement in students' mathematics learning outcomes. This discussion is based on the analysis of teacher and student activity observation sheets and the analysis of students' mathematics learning outcomes using the Problem-Based Learning model. Interviews with the class VIIIc mathematics teacher at the UPT SMPN 10 Tapung during the initial observation before the intervention revealed that students' mathematics learning outcomes were still low because they tended to be passive in expressing their thoughts. Furthermore, students simply paid attention and listened to the teacher's explanations. Based on the initial observations, the researchers also improved the mathematics learning process in the class by implementing the Problem-Based Learning (PBL) model. The goal was to help improve students' mathematics learning outcomes.

The researcher's implementation of the PBL model actively influenced the learning process, particularly on student performance during learning activities, thus reducing teacher-centered learning. Students were also trained to work on contextual problems, making learning more memorable. This impacted student learning outcomes. Therefore, the implementation of the PBL model can improve the learning process. Based on data analysis and teacher and student activities, the implementation of the PBL model was running according to the lesson plan. The researcher's observations during the learning process in class VIIIc of UPT SMPN 10 Tapung showed the expected progress from the first to the fourth meeting.

The shortcomings in Cycle I became the basis for the researcher's discussion regarding the implementation of the learning process in Cycle II. Consequently, in the second cycle, the stages of the PBL model were implemented well at each meeting. This was also evident in the students' active participation in the learning process, such as responding to apperception by answering questions posed by the researcher. The implementation of the PBL model provided opportunities for students to actively participate in the learning process. Students boldly expressed their opinions and asked questions to the researcher, discussed worksheets in groups, and responded to the results of their presentations, resulting in more active learning, this finding also in line with some researches that has been published (Laine, 2022; Sarnoko et al., 2024).

The learning process was not without obstacles and shortcomings. Improvements were made to the learning process through teacher feedback sheets and student observation sheets. Improvements to the learning process in this study were conducted in the second cycle, based on the first reflection. Efforts were made to correct deficiencies in the previous meeting in subsequent meetings. In the second cycle, the implementation of the PBL learning model improved with each meeting. Students also became more accustomed to the PBL learning activities. Several obstacles were encountered throughout the research process. These obstacles stemmed from the researcher's shortcomings in the learning process. For example, the researcher did not manage time effectively for several learning stages, such as group assignments and student worksheets (LKS), which resulted in the formative tests not running smoothly in the first and second meetings.

During the first and second meetings, students struggled to work in groups and chose to work individually, with some copying their peers' answers. According to the researcher, this was due to students' unfamiliarity with PBL learning and group work. The shortcomings in the first cycle served as a guide for improvement. In cycle II, students began to become accustomed to the learning model, leading them to become more active in the learning process, with the researcher acting solely as a facilitator. In cycle II, the PBL learning model progressed well at each meeting. Any shortcomings were attributed to the researcher, who acted as the teacher. Efforts were made to correct deficiencies from the previous meeting in subsequent meetings. Students' mathematics learning outcomes improved significantly from the first summative test to the second summative test.Hasil analisis ketercapaian KKTP menunjukkan bahwa persentase siswa yang mencapai KKTP pada skor dasar 6 siswa (19,35%) bertambah menjadi 18 siswa (58,06%) pada siklus I dan pada siklus II bertambah menjadi 20 siswa (64,51%).

The results of the frequency distribution analysis indicate an increase in learning outcomes or a change in learning outcomes for the better, indicated by a decrease in the frequency of students scoring $x<73$ (low) and an increase in the frequency of students scoring $73\leq x<82$ (medium), $82\leq x>91$ (high), and $91\leq x>100$. The improvement is indicated by an increase in student learning outcomes based on the average, median, and mode between the baseline score to the Summative I test and from the Summative I test to the Summative II test. Based on the criteria for successful action, it can be concluded that the actions taken by the researcher indicate an improvement in the learning process after implementing the PBL model in class VIIIc of UPT SMPN 10 Tapung. This increase in student learning outcomes is due to the implementation of the PBL model, which has provided each student with an opportunity to understand the

learning material and increased student participation in group discussions. Students actively participate in discovering their own knowledge, making learning easier to understand and more sustainable. Furthermore, each group is required to work together. The learning process has increased activity and a sense of responsibility, as well as developing the ability to collaborate with other students. Based on the teacher and student activity sheets and the analysis of student mathematics learning outcomes, it can be concluded that the proposed action hypothesis is acceptable. Therefore, PBL learning can improve mathematics learning outcomes and increase the percentage of students achieving the KKTP (Student Competency Standards) achievement indicator in class VIIIc of UPT SMPN 10 Tapung in the even semester of the 2024/2025 academic year, on the topic "System of Linear Equations in Two Variables." Based on the description of the analysis of teacher and student activities, as well as the analysis of learning outcomes, it can be concluded that there has been an improvement in the learning process and student learning outcomes. Therefore, the results of this research analysis support the proposed action hypothesis: if the problem-based learning model is implemented in mathematics, it can improve the learning process and improve mathematics learning outcomes for class VIIIc students at UPT SMPN 10 Tapung in the 2024/2025 academic year.

4. Conclusion

Based on the research results and discussion, it can be concluded that the application of the Problem-Based Learning (PBL) model can improve the learning process and enhance mathematics learning outcomes, as well as increase the percentage of students achieving the KKTP (Student Competency Standards) achievement indicator in class VIIIc of UPT SMPN 10 Tapung in the even semester of the 2024/2025 academic year, in the topic of Systems of Linear Equations in Two Variables (SPLDV). Based on the discussion and conclusions of this research, the researcher proposes recommendations related to the application of the Problem-Based Learning (PBL) model in mathematics learning, including: 1. The application of the Problem-Based Learning (PBL) model can be used as an alternative learning model to improve the learning process and enhance students' mathematics learning outcomes. 2. Teachers or researchers can effectively guide students during the learning process and manage time better so that all stages can be implemented according to the Teaching Module.

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