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Implementation of Problem Based Learning Model on Function Transformation Material to Improve Student Learning Outcomes

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Abstract

This research is a Classroom Action Research (CAR) aimed at improving students' learning outcomes on the topic of function transformation through the implementation of the Problem Based Learning (PBL) model in Grade XII of MA Islamiyah Syafi'iyah during the 2024/2025 academic year. The research subjects consisted of 19 students. The study was conducted in two cycles, each consisting of four stages: planning, implementation, observation, and reflection. The data collection instruments included learning achievement tests and observation sheets for both student and teacher activities. The success indicator of this study was determined if at least 75% of the students achieved the Minimum Mastery Criterion (KKM) of 75, and there was an improvement in the average learning outcome in each cycle. The results showed that students' learning outcomes improved after the implementation of the PBL model. In Cycle I, the percentage of students who achieved mastery was 52.63% with an average score of 72.11. After the improvements made in Cycle II, the mastery percentage increased to 84.21% with an average score of 79.32. These findings indicate that the Problem Based Learning model can effectively enhance students' learning outcomes on the topic of function transformation. In conclusion, the Problem Based Learning (PBL) model is effective in improving students' mathematics learning outcomes, particularly in function transformation material, as it encourages student activeness, develops critical thinking skills, and facilitates conceptual understanding through contextual problem-solving activities.

Keywords | Classroom Action Research, Function Transformation, Learning Outcomes, Problem Based Learning

INTRODUCTION

Education is a planned and systematic process for developing qualified, knowledgeable, and character-based human resources. According to Law Number 20 of 2003 concerning the National Education System, education aims to develop students' potential to become faithful, knowledgeable, capable, creative, and independent individuals. In this context, learning in schools should not only focus on mastering material but also on developing higher-order thinking skills.

The success of a learning process in schools can generally be seen from the level of learning outcomes achieved by students after participating in teaching and learning activities. Each student's cognitive, affective, and psychomotor development abilities influence the learning outcomes received after the learning process is implemented.[1]. Meanwhile,[2] states that learning outcomes are an indicator of a teacher's success in delivering material and students' success in understanding and mastering the competencies taught. For teachers, learning outcomes serve as an evaluation tool to assess the effectiveness of the learning strategies and methods used. For students, learning outcomes serve as a benchmark for achieving competency after participating in the ongoing learning process. According to [3], Assessment theories and academic experts alike emphasize the importance of feedback on performance assessment tasks to support improvement and progress in student learning outcomes. Thus, learning outcomes not only reflect students' academic abilities but also reflect the level of success of the interaction between teachers and students during the learning process. Effective evaluation of learning outcomes can assist teachers in determining follow-up actions, whether in the form of enrichment for students who have completed the course or remedial measures for those who still require additional guidance.

One of the subjects that plays an important role in developing critical and logical thinking skills is mathematics.:[4], Mathematics is the study of structures and patterns, logistic analysis, and the relationships between structures and patterns. Specifically, Brown states that we need a theoretical understanding of structures and techniques to determine what is strong and what is weak in these structures. However, mathematics learning in schools still faces various challenges, including low student participation and suboptimal learning outcomes. Initial observations at MA Islamiyah Syafi'iyah showed that many students had difficulty understanding the material on function transformations, which includes translation, reflection, rotation, and dilation. Students

[1] Psikomotorik Terhadap And Hasil Belajar, "Algebra : Jurnal Pendidikan, Sosial Dan Sains" 3 (2023).

[2] Sukatmi, "Kaitan Teori Belajar Dengan Hasil Belajar Pada Pembelajaran Islam," *Jurnal Ilmu Tarbiyah Dan Keguruan* 2, No. 1 (2025): 177–86, Https://Ejournal.Edutechjaya.Com/Index.Php/Jitk.

[3] Mamoon, Kabir, And Ismat, "The Value And Effectiveness Of Feedback In Improving Students' Learning And Professionalizing Teaching In Higher Education," *Journal Of Education And Practice* 7, No. 16 (2016): 38–41, Www.Iiste.Org.

[4] Fahrurrozi And Syukrul Hamdi, *Metode Pembelajaran Matematika*, *Universitas Hamzanwadi Press*, 2017, Https://Febriliaanjarsari.Wordpress.Com/2013/01/21/Metode-Pembelajaran-Matematika-Inovatif/.

tended to memorize formulas without understanding their meaning and were less able to connect concepts with real-world applications. This condition was exacerbated by teacher-centered learning methods, where teachers predominantly explained the material without providing space for students to discover concepts independently.

This problem is also evident in student learning outcomes at MA Islamiyah Syafi'iyah, particularly in the topic of geometric transformations or function transformations. Based on the results of a daily test for 12th-grade students conducted on September 10, 2025, with 19 participants, only 3 students achieved learning completion with scores above the Minimum Completion Criteria (KKM) of 75. The highest score obtained by a student was 85. These data indicate that the average learning outcomes are still far below the expected minimum standard, thus concluding that most students experience difficulty understanding the concept of function transformation. Efforts to improve learning outcomes have been implemented through remedial activities, namely by reviewing material and discussing questions deemed difficult based on previous test results. However, the improvement has not been significant. This is suspected to be due to the teacher-centered learning approach used. In this approach, the teacher is the primary source of information, with students acting only as passive recipients. As a result, students are less engaged in the process of discovering concepts, asking questions, discussing, and thinking critically and independently.

Classroom observations also indicate that teachers have not yet implemented innovative learning models that can enhance student activity and understanding. The learning process tends to consist solely of theoretical explanations and practice exercises from worksheets, without involving students in real-world investigations or problem-solving. This situation demands innovative learning models that can shift the learning paradigm from passive to active, constructive, and student-centered. One model deemed relevant for implementation is Problem-Based Learning (PBL), as it emphasizes active student involvement in finding solutions through contextual problems.

According to [5], Teacher-centered learning causes students to be passive and tend to simply receive information without in-depth understanding. Therefore, innovations in learning models

[5] Abdul Mu'iz Rahmatjati, Adi Satrio Ardiansyah, And Rochmad Rochmad, "Effectiveness Of Problem Based Learning Integrated Steam On Students' Mathematical Problem Solving Ability," *Unnes Journal Of Mathematics Education* 12, No. 3 (2023): 270–79, Https://Doi.Org/10.15294/Ujme.V12i3.78959.

are needed that can encourage student activeness and improve their conceptual understanding. One learning model that can be used to address this problem is Problem-Based Learning (PBL). The problem-based learning model, also known as Problem Based Learning, is a learning approach that prioritizes active student involvement.[6] Meanwhile, according to [7] describes PBL as a pedagogical strategy. PBL encourages student-directed learning and focuses on solving meaningful, authentic, and open-ended problems without a single, predetermined answer. By implementing PBL in mathematics learning, particularly in the material of function transformation, students are expected to be able to understand concepts through more contextual learning experiences. Learning with the PBL model is a teaching model that challenges students to find solutions to contextual problems, both individually and in groups. [8]. In addition, interactions between students in small groups can foster a sense of cooperation and responsibility in learning. Several previous studies also support the effectiveness of the PBL model in mathematics learning. [9] found that the application of the Problem-Based Learning model was able to improve students' learning outcomes and critical thinking skills in geometry. This indicates that the PBL model is relevant for topics requiring visual and conceptual understanding, such as function transformations.

METHOD

This study used the Classroom Action Research (CAR) method with the primary goal of improving students' mathematics learning outcomes through the application of the Problem-Based Learning (PBL) model. This method was chosen based on its characteristics, which enable teachers to take concrete actions in the classroom to continuously improve teaching practices. According to [10], Classroom Action Research is reflective research conducted by teachers in their own classes to improve the quality of learning and increase student learning outcomes.

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[6] Maulidina Setyowati, Moh Romdan Syiraj, And Andika Adinanda Siswoyo, "Penerapan Model Pembelajaran Problem Based Learning (Pbl) Berbasis Asessmen Tes Pilihan Ganda Dalam Meningkatkan Hasil Belajar Bahasa Indonesia," *Jma)* 2, No. 12 (2024): 3031–5220.

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[8] Andi Yunarni Yusri, "Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Pemecahan Masalah Matematika Siswa Kelas Vii Di Smp Negeri Pangkajene," *Mosharafa: Jurnal Pendidikan Matematika* 7, No. 1 (2018): 51–62, Https://Doi.Org/10.31980/Mosharafa.V7i1.474.

[9] Persepsi Guru Et Al., "Yanuar Irfan Rhamdani, 2019 Persepsi Guru Pamong Mengenai Kompetensi Pedagogik Mahasiswa Ppg Pra Jabatan Program Keahlian Agribisnis Pengolahan Pertanian Universitas Pendidikan Indonesia | Repository.Upi.Edu | Perpustakaan.Upi.Edu" 1, No. 2015 (2019).

[10] Guru Et Al.

The PTK approach provides researchers with the opportunity to be directly involved in the learning process, reflect on the actions taken, and develop more effective learning strategies. In line with the opinion [11], PTK is collaborative because it involves teachers and researchers in planning, implementing, observing, and reflecting on actions to improve the quality of learning in the classroom. [12].

This research was conducted in two cycles, referring to the spiral model developed by Kemmis and McTaggart (1988) in Trianto (2014), which includes four stages of activity, namely: 1). Planning, namely compiling a learning plan by applying the Problem Based Learning model, preparing learning tools, observation instruments, and learning outcome assessment instruments. 2). Implementation of Action (Acting), namely implementing the learning process according to the plan that has been prepared by emphasizing contextual problem solving. 3). Observation (Observing), namely observing student and teacher activities during the learning process using an observation sheet. 4). Reflection (Reflecting), namely evaluating the results of observations and learning outcomes to determine improvement steps in the next cycle. This research was conducted in only two cycles due to the limited implementation time in PPL activities, where the allocation of practice time consists of four learning cycles. The first two cycles were used for adapting class conditions and identifying student learning difficulties, while the last two cycles were used for implementing problem-based learning actions.

The research data consisted of quantitative and qualitative data. Quantitative data were obtained from student learning test results at the end of each cycle to determine improvements in learning outcomes after the implementation of PBL. Meanwhile, qualitative data were obtained through observations, field notes, and teacher reflections, which provided an overview of student activities, motivation, and responses during the learning process. Data analysis was conducted using two approaches: descriptive qualitative analysis and descriptive quantitative analysis.
Assessment of learning outcomes refers to the Minimum Completion Criteria (KKM) for mathematics at MA Islamiyah Syafi'iyah, which is 75. The classical learning completion was calculated using the formula:

[11] Terhadap And Belajar, "Algebra : Jurnal Pendidikan, Sosial Dan Sains."

[12] Prio Utomo, Nova Asvio, And Fiki Prayogi, "Metode Penelitian Tindakan Kelas (Ptk): Panduan Praktis Untuk Guru Dan Mahasiswa Di Institusi Pendidikan," *Pubmedia Jurnal Penelitian Tindakan Kelas Indonesia* 1, No. 4 (2024): 19, Https://Doi.Org/10.47134/Ptk.V1i4.821.

$$Classical\ Completion\ Percentage = \frac{Number\ of\ students\ completed}{Total\ number\ of\ student}\ x\ 100\ \%$$

The classical completion percentage is used to determine the overall level of learning success.

Table 1. Classical Completion Criteria Guidelines

Percentage (%)	Category
> 85% of students achieved KKM	Very successful
80% – 85% of students achieve KKM	Succeed
65% – 79% of students achieve the Minimum Criteria (KKM)	Quite successful
< 65% of students achieved KKM	Not successful

The results of each cycle are then compared to see any improvement in both student learning activities and mathematics learning outcomes, so that it can be concluded that the effectiveness of applying the Problem Based Learning model in improving learning outcomes in the material on function transformation..

RESULTS AND DISCUSSION

3.1 Pre Cycle

Each cycle in this study served as a basis for reflection to improve and enhance student learning outcomes in the next stage. Before the learning activities were implemented, the researchers first collected initial data in the form of pre-cycle scores. This data was obtained through a diagnostic test given to students before the implementation of the activities. The results of the pre-cycle test indicated that most students still had difficulty understanding the material on function transformation, indicating that their level of conceptual mastery was still low. An overview of the pre-cycle results can be seen in Table 2 below.

Table 2. Initial Diagnostic Results of Function Transformation Material

Criteria	Number of	Percentage

	students	
Completed	2	11%
Not yet finished	17	89%
Amount	19	100%

Based on the data in Table 2, it is known that out of 19 students, only 2 students (11%) have achieved the Minimum Completion Criteria (KKM = 75), while 17 students (89%) have not completed it. This indicates that most students still have difficulty in understanding the material on function transformation. This low level of completion indicates the need for the implementation of more innovative and interactive learning models, such as Problem-Based Learning (PBL), so that students are more active in the learning process and are able to improve their learning outcomes.

3.2 Actions in cycle 1

a. Planning

To implement the Problem-Based Learning (PBL) model on the transformation of functions, particularly the rotation sub-topic, the planning stage in Cycle I began with the development of a teaching module tailored to the characteristics of class XII students at MA Islamiyah Syafiiyah. The teaching module was prepared for use at the beginning of the learning process as a guide for teachers and students in learning activities.

The planning steps in Cycle I include:

1. Prepare teaching materials and learning media that are relevant to the rotation material in function transformation.
2. Develop teaching modules by integrating problem-based learning steps.
3. Prepare research instruments such as observation sheets, student worksheets (LKPD), and evaluation questions to be used during the action process.

b. Implementation

The implementation of the actions in Cycle I was carried out on Wednesday, September 17, 2025, in class XII MA Islamiyah Syafiiyah, with a total of 19 students. The material discussed was rotation in function transformation, which was taught using the Problem-Based Learning (PBL) model. The learning process was centered on students (student-centered learning), where they were actively involved in identifying, analyzing, and solving contextual problems related to the concept of rotation.

The activity begins with an explanation of the learning objectives and an apperception session to connect the rotation material to the previous concept of function transformation. The teacher then motivates students through provocative questions that require critical and logical thinking skills. Afterward, students are divided into small, heterogeneous groups to discuss and solve problems contained in the worksheet.

Throughout the activity, the teacher acts as a facilitator, providing guidance and encouragement so students can find solutions through independent thinking. After the discussion concludes, group representatives are randomly selected to present their findings to the class. The teacher then provides clarification and conceptual reinforcement to ensure all students fully understand the material.

To measure student understanding, a formative test was conducted at the end of the lesson using a previously prepared evaluation instrument. This evaluation aimed to determine the extent to which the problem-based learning model was able to improve student learning outcomes on rotation in function transformation.

c. Observation and Interpretation

The following are the assessment results from cycle 1 in Table 3.

Table 3. Student Learning Outcomes in Cycle 1 Rotation Sub-Material

KKM (75)	Results of Cycle I	Percentage
Completed (≥ 75)	10	52,6%
Not Completed (≥ 75)	9	47,4%
Amount	19	100%

In Cycle I, which focused on the rotation sub-material in function transformation, data obtained showed that out of a total of 19 students, 10 students (52.6%) had achieved KKM ≥ 75, while 9 students (47.4%) were still below the KKM. The average class score in this cycle was 74.21, which indicates that the overall student learning outcomes were still slightly below the set completion standards.

Nevertheless, the increase in the number of students completing the course compared to the pre-cycle indicates that the implementation of the Problem-Based Learning (PBL) model has begun to have a positive impact on students' conceptual understanding. However, because the classical completion rate has not yet reached the minimum threshold of success (≥ 80% of students completing the course), reflection and improvement of learning strategies are needed in the next cycle to optimally improve student learning outcomes.

d. Cycle I Reflection

Based on the results of observations and data analysis in Cycle I, it can be concluded that the implementation of the Problem-Based Learning (PBL) model has begun to show an increase in student learning outcomes compared to pre-cycle conditions. This is evident from the increase in the number of students achieving the Minimum Competency (KKM) of 75, namely 10 students (52.6%) with a class average of 74.21. Although this increase shows a positive direction, the results still do not meet the criteria for classical learning success, namely a minimum of 80% of students achieving the Minimum Competency (KKM).

During the learning process, several obstacles were identified that impacted learning outcomes. Some students remained passive in group discussions, relying solely on more active peers, and were reluctant to express their opinions when faced with contextual problems. Furthermore, time management during the discussion process was suboptimal, resulting in limited and incomplete presentations of group work.

From the results of this reflection, the researcher and partner teachers concluded that it was necessary to improve the strategy for implementing the PBL model in Cycle II, including by:

1. Provide clearer directions regarding the role of each group member so that all students are actively involved in the discussion.
2. Prepare student worksheets that are more focused and tailored to students' ability levels, so that students can gradually understand the problem.
3. Manage learning time more effectively by setting appropriate time limits for discussions and presentations.
4. Provide immediate feedback after group presentations to reinforce proper conceptual understanding.

Through these improvements, it is hoped that in Cycle II, student involvement in the learning process will increase, understanding of the concept of function transformation (especially rotation) will be better, and student learning outcomes can achieve classical mastery of at least 80%.

3.3 Actions in Cycle II

a. Planning

The implementation of Cycle II was prepared by referring to the results of reflections from activities in Cycle I. Several obstacles that emerged in the previous implementation were used as a reference for making improvements so that learning would be more effective. The problems found in Cycle I included: some students did not pay attention during the learning process because they were busy with other activities, the group division process took quite a long time, and the low level of student understanding of the dilation material that had not yet reached the Minimum Completion Criteria (KKM). Based on these findings, the action plan in Cycle II focused on efforts to improve these aspects so that the learning implementation could take place more optimally and student learning outcomes would improve. The following is the action plan prepared:

1. Designing more engaging and interactive material presentations, linking them to real-life situations that students can easily understand. Teachers utilize technology-based learning media, such as GeoGebra or dynamic visual displays, to facilitate a more concrete understanding of the concept of dilation.
2. Refining the teaching materials used, particularly in the Problem-Based Learning (PBL) model. Adjustments were made based on the results of Cycle I reflections, such as providing clearer group work instructions, accelerating the group formation process, and adding a concept reinforcement phase to strengthen student understanding.
3. Preparing more comprehensive and focused research tools, including observation sheets, student worksheets (LKPD), and revised formative evaluation questions. These instruments are designed to more objectively record student engagement, the quality of group collaboration, and learning progress.
4. Implementing more effective classroom management strategies, particularly to address discipline and time management challenges. Each group is assigned a clear role (such as leader, writer, and presenter), and the teacher provides systematic activity instructions at the beginning of the lesson to ensure a more orderly and efficient learning process.

b. Implementation

The actions in Cycle II were implemented based on the reflections from Cycle I, with the aim of correcting any remaining deficiencies. Learning activities in this cycle took place on Wednesday, September 24, 2025, in class XI of MA Islamiyah Syafi'iyah, with 19 students. The material remained focused on function transformations, particularly the dilation subtopic, but with a more focused and effective implementation strategy.

In the introductory phase, the teacher began the activity by conveying the learning objectives, briefly reviewing the previous material, and providing an apperception through contextual examples of problems related to geometric transformations (dilation). The teacher also motivated students to be more active and participate during the lesson. Next, in the main activity phase, students were divided into small groups with predetermined roles (leader, note-taker, and presenter). The teacher guided each group in understanding the given problem and directed students to use GeoGebra or visual media to facilitate their understanding of the rotation concept. Group discussions were more focused because instructions were clearly communicated at the beginning. In the presentation phase, representatives from each group presented their results to the class. The teacher and other students provide feedback and clarification to strengthen shared understanding.

The closing stage involves reflection and concept reinforcement by the teacher. The teacher and students summarize the day's learning outcomes and then administer a formative evaluation test to determine the extent to which student learning has improved following the intervention..

In general, the implementation of Cycle II was more conducive compared to Cycle I. Students appeared more active, enthusiastic, and able to work together well in groups.c. Observasi dan interpretasi

Student learning outcomes in cycle 2 can be seen more clearly in Table 4 below.

Table 4. Student Learning Outcomes for Dilation Sub-Material

KKM (75)	Hasil Siklus II	Persentase
Completed (≥ 75)	16	84,21%
Not Completed (≥ 75)	3	15,79%
Amount	19	100%
Average learning outcomes	79,32	

Based on the data in Table 4, it is known that of the 19 students, 16 (84.21%) achieved the Minimum Competency (KKM) (≥ 75), while 3 students (15.79%) had not yet completed the course. The average student learning outcome score in this cycle was 79.32, indicating an improvement compared to the results in the previous cycle.

This improvement demonstrates that the implementation of the problem-based learning model, coupled with improvements in learning strategies in the second cycle, such as the use of interactive media and more effective time management, was able to improve students' understanding of the material on function transformations, particularly rotations.

Although learning completion was not yet 100%, the results showed positive developments and significant improvements compared to the first cycle. Therefore, the actions taken in the second cycle can be declared successful in improving student learning outcomes and are worthy of being maintained and developed in subsequent learning activities.

d. Reflection and evaluation

Based on the results of the implementation of the actions in Cycle II, it can be concluded that the learning process was more effective compared to Cycle I. Students appeared more active in group discussions, showed higher enthusiasm in solving the given problems, and were quicker in understanding the concept of rotation in the geometric transformation material. Improvements made in the planning stage, such as the use of visual-based learning media and the application of the GeoGebra application, were proven to be able to help students visualize the rotation of objects more concretely. In addition, the division of roles within the group (leader, writer, presenter) also increased the involvement and responsibility of each group member. From the evaluation results, there was an increase in learning completeness from the previous cycle, with 84.21% of students having achieved the Minimum Competency (KKM), and the class average increased to 79.32. This indicates that the problem-based learning model (PBL) is able to have a positive impact on student learning outcomes and motivation. Overall, the actions in Cycle II can be declared successful because the research objective, namely improving student learning outcomes in the geometric transformation material, has been achieved. However, several aspects such as concept reinforcement and discussion time management still need to be considered so that results obtained in the future can be more optimal.

The following is a more complete comparison of the learning outcomes data for class XII students in cycles 1 and 2.

Table 5. Comparison of Cycles 1 and 2

Assessment criteria	Results of cycle 1	Results of cycle 2
Percentage of Completion	52,63%	84,21%
Average learning outcomes	72,11	79,32

Based on the data in Table 5 above, there is an increase in student learning outcomes from Cycle I to Cycle II. In Cycle I, only 10 students (52.63%) achieved the Minimum Completion Criteria (KKM) (≥75), with an average class score of 72.11. After improvements were made to the learning process in Cycle II, the number of students who completed the learning increased to 16 students (84.21%), with an average class score also increasing to 79.32. This increase indicates that the implementation of the Problem Based Learning (PBL) model has proven effective in helping students understand the concept of function transformation, especially in the rotation sub-topic. Through problem-based learning, students become more active, directly involved in finding solutions, and are able to relate mathematical concepts to real-world situations. Overall, the results in Cycle II indicate that the target for improving learning outcomes has been achieved. Thus, the application of the Problem Based Learning (PBL) model can be recommended for use in mathematics learning, especially in materials that require conceptual understanding and critical thinking skills such as geometric transformations. A comparison of cycles 1 and 2 is presented in

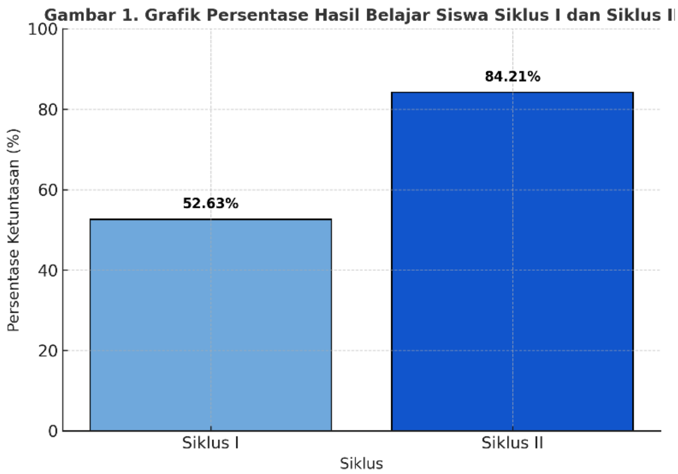

Figure 1 below.

CONCLUSION *(Palatino Linotype 11, Space 1.5, Justify)*

Based on the results of classroom action research that applies the Problem Based Learning (PBL) learning model to the material of function transformation, it can be concluded that the application of the model can significantly improve the learning outcomes of class XII students of MA Islamiyah Syafi'iyah. The results showed that the percentage of classical completeness increased from 52.63% in Cycle I to 84.21% in Cycle II. In addition, the average student score increased from 72.11 to 79.32, with the highest score obtained by students reaching 90. This increase indicates that the PBL model is effective in helping students understand the concept of function transformation better. In Cycle II, the teacher made several improvements from the previous cycle, such as providing clearer directions at the beginning of the lesson, dividing groups effectively, and strengthening student involvement in the discussion process. The teacher also provided LKPD that were arranged more systematically and contextually, making it easier for students to follow the steps to solve problems. In addition, the use of visual and interactive media during learning also helped students understand the concept of function transformation in a concrete way. Thus, it can be concluded that the application of the Problem Based Learning model not only improves students' learning outcomes but also fosters their critical thinking skills, cooperation, and activeness in the learning process.

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