==

Improving Mathematics Learning Outcomes Using the Problem Based Learning Model on Function Material in Grade XI

Ardilatus Sholehah[1], Shofia Hidayah[2], Suhartono[3]
[12] Universitas Nurul Jadid,[3] MAN 1 Probolinggo, Indonesia
correspondence e-mail*, ardilatus@gmail.com[1], shofiahidayah@unuja.ac.id[2],
suhartono1124@gmail.com[3]

| **Abstract** | This study aims to improve student learning outcomes in Function material through the application of the Problem Based Learning (PBL) model in class XI-C MAN 1 Probolinggo. This study is a Classroom Action Research (CAR) carried out in two cycles, each consisting of planning, action implementation, observation, and reflection. The subjects of the study were 24 students of class XI-C MAN 1 Probolinggo. Data were collected through observation of student activities and learning outcome tests at the end of each cycle. The results of the study showed an increase in student learning outcomes after the application of the problem based learning (PBL) model. The average value of learning outcomes increased from 66 in the pre-cycle to 71.5 in cycle I, and then increased again to 94.83 in cycle II. With learning completeness from 37.5% to 62.5%, and increased again to 100%. In addition, student activity and involvement in the learning process also showed a significant increase. Based on these results, it can be concluded that the application of the Problem Based Learning model is effective in improving student learning outcomes in Function material in class XI-C MAN 1 Probolinggo. This model can be an alternative innovative learning strategy to create an active, meaningful, and student-centered learning process. |

INTRODUCTION

Mathematics is often considered the foundation of higher secondary education due to its contribution to developing logical and analytical thinking skills, as well as problem-solving skills, which are crucial for academic progress and daily activities.[1] Mathematical skills extend beyond calculation or symbol manipulation; they encompass conceptual understanding, mathematical representation, and the application of concepts to real-world situations.[2] When students grasp

---

[1] Intan Mahyastuti, Dwiyana, and Erry Hidayanto, 'Kemampuan Berpikir Analitis Siswa Dalam Memecahkan Masalah Matematis Students ' Analytical Thinking Ability in Mathematical Problems Solving', *Jurnal Pendidikan Matematika Dan Sains*, 8.1 (2020), 1–6.
[2] Karimah Tauhid, Yusuf Safari, and Pina Nurhida, 'Karimah Tauhid, Volume 3 Nomor 9 (2024), e-ISSN

mathematical structures well, they are prepared to think abstractly, solve problems, and make decisions based on logic and data.[3] However, several studies have shown that students' conceptual understanding of mathematics is often lacking, especially when the learning process emphasizes memorizing formulas and mechanical problem-solving.[4] This situation suggests that mathematics teaching methods require approaches that can develop in-depth conceptual mastery and higher-level critical thinking skills.[5]

Furthermore, the sub-topics of composition and inverse functions play a central role in building students' mathematical reasoning structures because they are directly related to the concept of operations on functions and the formation of relational equivalence.[6] Function composition helps students understand how two mathematical relations can be connected to form new relations.[7] While inverse functions require students to reinterpret relational transformations in reverse.[8] Previous research found that most students were only able to correctly solve word problems involving composition or inverse functions, indicating a low understanding of the relationships between functions.[9] Meanwhile, other findings revealed that using a didactic approach that emphasizes conceptual understanding helps reduce students' misconceptions about inverses and composition of functions.[10] These findings support the argument that if basic mastery of functions is weak, students' abilities to think abstractly and model contextual problems will be impaired, not just academic grades.

The results of initial observations in class XI-C MAN 1 Probolinggo showed that most students experienced difficulties not only in their arithmetic abilities, but also in understanding the fundamental concept of functions. Students had difficulty determining domain-codomain-range,

---

2963-590X', 3 (2024), 9817–24.

[3] Novita Andika Pramuswara and Haerudin Haerudin, 'Pengaruh Kemampuan Pemahaman Konsep Matematis Terhadap Kemampuan Pemecahan Masalah Matematis Siswa', *JP2M (Jurnal Pendidikan Dan Pembelajaran Matematika)*, 10.1 (2024), 96–103 <https://doi.org/10.29100/jp2m.v10i1.5260>.

[4] Jurnal Riset and Hots Pendidikan, 'Kognitif', 3 (2023), 49–71.

[5] Indriyani Eneng, Hidayat Hidayat, and Yandhari Vivi, 'The Effectiveness of the Realistic Mathematics Education (RME) Approach in Improving Fifth Grade Students' Understanding of Mathematical Concepts', 4.2 (2020), 1–8 <https://ejournal.undiksha.ac.id/index.php/JISD/index>.

[6] Asti Parwati, Adi Asmara, and Winda Ramadianti, 'Desain Didaktis Konsep Invers Fungsi Komposisi Untuk Siswa Sekolah Menengah Atas', *Jurnal Riset Pembelajaran Matematika Sekolah*, 8.2 (2024), 1–8 <https://doi.org/10.21009/jrpms.082.01>.

[7] Ida Nurjannah and others, 'Analisis Kemampuan Pemahaman Konsep Matematis Siswa Pada Materi Fungsi Komposisi Dan Invers Berdasarkan Jenis Kelamin', *Journal on Education*, 06.04 (2024), 22760–68.

[8] Pinkan Pramesti and Ferry Ferdianto, 'Analisis Kesulitan Siswa Belajar Matematika Pada Materi Fungsi Komposisi Dan Fungsi Invers Kelas X SMA Negeri 1 Rajagaluh', *Jurnal Pendidikan Matematika Dan Sains*, 7.2 (2021), 74–79 <https://doi.org/10.21831/jpms.v7i2.25243>.

[9] Dhitamaulia Mahfuud and Heni Pujiastuti, 'Pada Materi Fungsi Komposisi Dan Fungsi Invers', 3.2 (2020), 51–54.

[10] Asti Parwati, Asmara, and Ramadianti.

solving composition problems of functions and inverse functions, relying solely on memorizing formulas without understanding the meaning of relationships between sets. This indicates that conventional learning processes have not been able to stimulate in-depth understanding. This phenomenon is in line with recent research in mathematics education, which states that students in various countries face similar challenges in learning functions, because these concepts require abstract understanding. Another study revealed that most students experience difficulties connecting the concept of functions to the context of word problems, particularly in determining the domain, range, and meaning of relationships between variables.[11] Similarly, a common student error lies in the inability to understand the structure of function composition, which impacts the generalization and problem-solving process.[12] Furthermore, misconceptions in function material often arise because students are unable to conceptually understand graphical representations and variable changes.[13] These findings confirm that the difficulties faced by students at MAN 1 Probolinggo are not isolated cases, but rather part of a general phenomenon in function learning in Indonesia.

This lack of conceptual understanding directly impacts student learning outcomes and confidence in mathematics. Students tend to be passive, less engaged in discussions, and wait for examples from the teacher to provide solutions, thus limiting opportunities to develop logical reasoning and problem-solving skills. Previously showed that learning motivation and learning independence significantly contribute to mathematics learning outcomes; students who lack confidence and are not accustomed to independent learning are at greater risk of experiencing difficulties in understanding the material.[14] Another finding confirmed that self-confidence is a key factor determining student success in understanding mathematics material, including when dealing with concepts that require high-level reasoning.[15] Therefore, implementing learning strategies that provide space for students to actively participate, explore ideas, and construct understanding independently is crucial.

In response to these challenges, active learning methods such as problem-based learning

---

[11] Mahfuud and Pujiastuti.

[12] Asrori Septa Sugianto and others, 'Analisis Kesalahan Siswa SMA/SMK Dalam Menyelesaikan Soal Matematika Pada Fungsi Komposisi', *Indonesian Journal of Science, Technology and Humanities*, 1.1 (2023), 30–38 <https://doi.org/10.60076/ijstech.v1i1.9>.

[13] Invers Pada and others, '* Corresponding Author. KM 12, Kota Sorong, Indonesia', 2.2 (2024), 101–10.

[14] Lambok Simamora, Ul'fah Hernaeny, and Destia Dwi Lucyta Dewi, 'Pengaruh Motivasi Dan Kemandirian Belajar Terhadap Pemahaman Konsep Matematika', *Jurnal Review Pendidikan Dan Pengajaran*, 7.3 (2024), 10181–88 <http://journal.universitaspahlawan.ac.id/index.php/jrpp>.

[15] Desi Gita Andriani, 'The Effect of Self-Confidence on Students' Understanding of Mathematical Concepts through the Implementation of the Independent Curriculum', *Noumerico: Journal of Technology in Mathematics Education*, 1.1 (2023), 1–9 <https://doi.org/10.33367/jtme.v1i1.3548>.

(PBL) have emerged as a frequently recommended solution. PBL focuses on student participation in solving real-world problems, which can improve conceptual understanding, mathematical literacy, and problem-solving skills. Recent research indicates that the application of problem-based learning (PBL) consistently correlates positively with improvements in students' mathematical problem-solving abilities and mathematical literacy, compared to conventional teaching methods. A literature review found that PBL is effective in improving mathematical literacy because it encourages students to construct knowledge through authentic investigation and problem-solving.[16] This finding aligns with experimental research which showed that students learning with a PBL approach have better mathematical problem-solving skills than students receiving traditional instruction.[17] Additional support comes from research reported that PBL integration significantly improves mathematical literacy scores because it provides students with opportunities to interpret, analyze, and apply mathematical concepts in new contexts.[18]

Furthermore, this study aims not only to improve learning outcomes but also to enhance the mathematics learning process by increasing student engagement, problem-solving skills, and a deeper conceptual understanding of functions. Problem-based learning (PBL) provides a learning framework that allows students to collaborate in solving contextual problems, presenting findings, and reflecting on their thinking processes. Furthermore, the implementation of Problem-Based Learning can significantly improve students' mathematical reasoning abilities and learning independence.[19] These results are in line with findings that prove that students who learn using PBL have better mathematical problem-solving skills than students who learn through traditional methods.[20] Additional support reports that PBL integration can significantly improve mathematical literacy because this model provides students with opportunities to analyze, interpret, and apply mathematical concepts in various new contexts.[21] Therefore, the implementation of PBL in class XI-C MAN 1 Probolinggo has academic and pedagogical urgency.

---

[16] Aulia Firdaus and others, 'Problem Based Learning (PBL) Untuk Meningkatkan Kemampuan Matematika Siswa', *QALAMUNA: Jurnal Pendidikan, Sosial, Dan Agama*, 13.2 (2021), 187–200 <https://doi.org/10.37680/qalamuna.v13i2.871>.

[17] Selpia Anggraini Susino, Destiniar Destiniar, and Eka Fitri Puspa Sari, 'The Influence of the Problem Based Learning (PBL) Learning Model on the Mathematical Problem Solving Abilities of Class X High School Students', *Jurnal Cendekia : Jurnal Pendidikan Matematika*, 8.1 (2023), 53–61.

[18] Jurnal Inovasi, Penelitian Pendidikan, and Pembelajaran Vol, 'Recolecta - 2020 - Unknown - 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1', 4.2 (2024), 361–66.

[19] Inayatul Karimah and Loviga Denny Pratama, 'Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Kemampuan Penalaran Matematis Dan Kemandirian Belajar Siswa', *SEMESTA: Jurnal Ilmu Pendidikan Dan Pengajaran*, 3.1 (2025), 1–6 <https://doi.org/10.70115/semesta.v3i1.158>.

[20] Susino, Destiniar, and Sari.

[21] Inovasi, Pendidikan, and Vol.

Based on the description above, this study focuses on "Improving Mathematics Learning Outcomes Using Problem Based Learning Model on Function Material in Grade XI". The purpose of this study is to improve student learning outcomes on function material through the application of problem-solving-based learning that encourages students to analyze real situations, identify the variables involved, formulate relevant function representations, and evaluate solutions independently and collaboratively. Through the application of problem-based learning models, this approach is expected to increase student activeness during the learning process, strengthen critical thinking skills, and encourage systematic reasoning habits in solving mathematical problems.

METHOD

This study applies the Classroom Action Research (CAR) method using the spiral model developed by Kemmis and McTaggart, which includes the stages of planning, action implementation, observation, and reflection in each cycle.[22] This approach was chosen because it is relevant to addressing learning problems that arise directly in the classroom. This research was conducted in class XI-C MAN 1 Probolinggo during the odd semester of the 2025/2026 academic year, with the aim of improving mathematics learning outcomes through the application of the Problem Based Learning (PBL) model on the material of functions. This research was conducted in two cycles. The planning process included the preparation of learning tools needed to support the problem-based learning (PBL) model, consisting of Student Worksheets (LKPD), observation sheets, and learning outcome test instruments tailored to the material indicators in grade XI. These test instruments were designed to assess students' understanding of the material's core competencies, particularly in determining domain-codomain-range, solving function compositions, and inverse functions.

The action is implemented using a problem-based learning model that emphasizes solving real-world problems as an introduction to learning. Students then work in groups to analyze the problem, formulate strategies to solve it, and present their mathematical thinking. The teacher's role is to support students when needed so they can build understanding independently and collaboratively. Throughout the learning process, the teacher and observers will observe student engagement, the quality of discussions, the effectiveness of interactions in learning, and how the use of PBL helps students understand the material on functions. Observations were conducted

---

[22] Torang Siregar, 'Classroom Action Research-Based Learning Innovations : Kemmis and McTaggart Models', 1.3 (2025).

throughout the learning process to gather data on student engagement and the effectiveness of PBL implementation. Furthermore, reflection was conducted to identify successes and shortcomings of the current cycle, allowing improvements to be integrated into the next cycle. The study was deemed successful if there was an increase in the quality of learning activities and at least 85% of students achieved the Minimum Competency (KKM).

RESULTS AND DISCUSSION

Results

The students' learning outcomes on functions were demonstrated at each stage of the action. In the pre-cycle, only 9 out of 24 students achieved learning completion with an average score of 66, resulting in a completion percentage of only 37.5%. This indicates that most students still have difficulty understanding the concept of functions and applying it to problems. After implementing the problem-based learning model in cycle I, the average score was 71.5, with the number of students completing the course increasing to 15, or 62.5%. However, there are still 9 students who haven't completed the course, so we need to improve our teaching methods to help those who are still struggling.

The learning improvements implemented in Cycle II resulted in even more significant improvements. The class average score rose to 94.83, with 24 students (100%) achieving completion, exceeding the Minimum Completion Criteria (KKM). This demonstrates that the implementation of problem-based learning coupled with optimized student activities can improve overall learning outcomes.

Table 1. Student Learning Outcomes Completion in Each Cycle

Learning Stage	Average value	Number of Studens Completed	Number of Incomplete Studens	Percentage of completion
Pre-cycle	66	9 studens	15 studens	37%
Cycle I	71,5	15 studens	9 studens	62,5
Cycle II	94,83	24 studens	0 studens	100%

Discussion

Learning outcome completion data showed significant changes from pre-cycle to cycle II. In the pre-cycle, most students did not understand the function material well, reflected in only 9

students who completed it while 15 others had not completed it or had not reached the Minimum Completion Criteria (KKM). This condition is in accordance with the observation results that many students still experience difficulties in determining the domain-codomain-range, solving function compositions and inverse functions. The learning model used previously tended to be teacher-centered so that students only received information without the opportunity to explore concepts independently.

In cycle I, the implementation of problem-based learning (PBL) began to show positive impacts. The completion rate increased to 15 students completing the task and 9 students failing to complete it. PBL encouraged students to work in groups, identify problems, formulate hypotheses, and develop solutions through discussion. This mechanism provided opportunities for students to understand functions in greater depth, not just using algebraic symbols. However, the improvement in cycle I was not comprehensive, as evidenced by the fact that some students were not actively involved during problem-solving and remained confused when solving function composition and inverse function problems.

Through reflection at the end of cycle I, revised actions were implemented in cycle II. The teacher strengthened the guidance of group discussions, provided scaffolding in problem analysis, and required each group member to contribute to problem-solving. This strategic change resulted in significant improvement in cycle II: all 24 students achieved completion. These findings indicate that PBL effectively helps students understand the concept of function because their thinking processes are developed through problem exploration and social interaction, rather than simply listening to teacher explanations. Overall, the results of this study indicate that PBL not only improves students' grades, but also strengthens analytical thinking skills, conceptual understanding, collaboration, and learning independence. PBL syntax that requires students to think critically about real-world problems is proven to be relevant to the character of the function material that requires linking between representations. The increase in completeness in cycle II provides empirical evidence that targeted action interventions, implemented continuously through improvement cycles, are able to overcome learning difficulties that were initially dominant in class XI-C MAN 1 Probolinggo.

CONCLUSION

This classroom action research confirms that the implementation of the Problem Based Learning (PBL) model can significantly improve students' mathematics learning outcomes in the function material of class XI-C MAN 1 Probolinggo through a process of repeated, reflective

actions, and based on actual learning needs in the classroom. Pre-cycle conditions show a gap between student learning outcomes and competency standards, which is caused by conventional teacher-centered learning patterns that make students passive, less involved in mathematical reasoning, and only follow problem-solving procedures without understanding the concept in depth. The findings in cycle I show that the implementation of PBL has begun to create positive changes because students are encouraged to construct knowledge through contextual problem solving, although the activeness and independence of thinking are not evenly distributed across all groups.

Improvements in strategies in cycle II through more structured discussion guidance, scaffolding when students had difficulty finding solutions, and emphasizing the roles and contributions of each group member resulted in a much more equitable increase in learning engagement. These changes in learning behavior resulted in improved understanding of function concepts, mathematical modeling skills, and mathematical communication skills through presentations of discussion results. The increase in learning outcomes completion to 100% in cycle II not only demonstrated students' success in solving problems but also reflected a more stable internalization of concepts and the ability to apply concepts in real-world problem contexts.

Thus, it can be concluded that the Problem Based Learning model is effective in improving mathematics learning outcomes when applied consistently, taking into account student readiness, the quality of the problems presented, and the academic guidance mechanism during the discussion process. Furthermore, the success of PBL is greatly influenced by students' active involvement in identifying problems, formulating problem-solving strategies, and reflecting on the understanding gained. This study also indicates that the role of the teacher is not as the sole source of information, but rather as a facilitator, mediator, and guide for the thinking process. Therefore, the implementation of PBL not only impacts academic grades but also forms the critical, collaborative, and independent thinking patterns needed in advanced mathematics learning.

REFERENCES

Asti Parwati, Adi Asmara, and Winda Ramadianti, 'Desain Didaktis Konsep Invers Fungsi Komposisi Untuk Siswa Sekolah Menengah Atas', *Jurnal Riset Pembelajaran Matematika Sekolah*, 8 (2024), 1–8 <https://doi.org/10.21009/jrpms.082.01>

Firdaus, Aulia, Mohammad Asikin, Budi Waluya, and Zaenuri Zaenuri, 'Problem Based Learning (PBL) Untuk Meningkatkan Kemampuan Matematika Siswa', *QALAMUNA: Jurnal Pendidikan, Sosial, Dan Agama*, 13 (2021), 187–200 <https://doi.org/10.37680/qalamuna.v13i2.871>

Gita Andriani, Desi, 'The Effect of Self-Confidence on Students' Understanding of Mathematical Concepts through the Implementation of the Independent Curriculum', *Noumerico: Journal of Technology in Mathematics Education*, 1 (2023), 1–9 <https://doi.org/10.33367/jtme.v1i1.3548>

Indriyani Eneng, Hidayat Hidayat, and Yandhari Vivi, 'The Effectiveness of the Realistic Mathematics Education (RME) Approach in Improving Fifth Grade Students' Understanding of Mathematical Concepts', 4 (2020), 1–8 <https://ejournal.undiksha.ac.id/index.php/JISD/index>

Inovasi, Jurnal, Penelitian Pendidikan, and Pembelajaran Vol, 'Recolecta - 2020 - Unknown - 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1', 4 (2024), 361–66

Karimah, Inayatul, and Loviga Denny Pratama, 'Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Kemampuan Penalaran Matematis Dan Kemandirian Belajar Siswa', *SEMESTA: Jurnal Ilmu Pendidikan Dan Pengajaran*, 3 (2025), 1–6 <https://doi.org/10.70115/semesta.v3i1.158>

Mahfuud, Dhitamaulia, and Heni Pujiastuti, 'Pada Materi Fungsi Komposisi Dan Fungsi Invers', 3 (2020), 51–54

Mahyastuti, Intan, Dwiyana, and Erry Hidayanto, 'Kemampuan Berpikir Analitis Siswa Dalam Memecahkan Masalah Matematis Students ' Analytical Thinking Ability in Mathematical Problems Solving', *Jurnal Pendidikan Matematika Dan Sains*, 8 (2020), 1–6

Nurjannah, Ida, Rizky Esti Utami, Suprihatin, and Lilik Ariyanto, 'Analisis Kemampuan Pemahaman Konsep Matematis Siswa Pada Materi Fungsi Komposisi Dan Invers Berdasarkan Jenis Kelamin', *Journal on Education*, 06 (2024), 22760–68

Pada, Invers, Kelas Xi, D I Sma, and Teknologi Kota, '* Corresponding Author. KM 12, Kota Sorong, Indonesia', 2 (2024), 101–10

Pramesti, Pinkan, and Ferry Ferdianto, 'Analisis Kesulitan Siswa Belajar Matematika Pada Materi Fungsi Komposisi Dan Fungsi Invers Kelas X SMA Negeri 1 Rajagaluh', *Jurnal Pendidikan Matematika Dan Sains*, 7 (2021), 74–79 <https://doi.org/10.21831/jpms.v7i2.25243>

Pramuswara, Novita Andika, and Haerudin Haerudin, 'Pengaruh Kemampuan Pemahaman Konsep Matematis Terhadap Kemampuan Pemecahan Masalah Matematis Siswa', *JP2M (Jurnal Pendidikan Dan Pembelajaran Matematika)*, 10 (2024), 96–103 <https://doi.org/10.29100/jp2m.v10i1.5260>

Riset, Jurnal, and Hots Pendidikan, 'Kognitif', 3 (2023), 49–71

Simamora, Lambok, Ul'fah Hernaeny, and Destia Dwi Lucyta Dewi, 'Pengaruh Motivasi Dan Kemandirian Belajar Terhadap Pemahaman Konsep Matematika', *Jurnal Review Pendidikan Dan Pengajaran*, 7 (2024), 10181–88 <http://journal.universitaspahlawan.ac.id/index.php/jrpp>

Siregar, Torang, 'Classroom Action Research-Based Learning Innovations : Kemmis and McTaggart Models', 1 (2025)

Sugianto, Asrori Septa, Lutfi Cahya Kurniawan, Nila Alfi Rosyidah, and Indah Wahyuni, 'Analisis

Kesalahan Siswa SMA/SMK Dalam Menyelesaikan Soal Matematika Pada Fungsi Komposisi', *Indonesian Journal of Science, Technology and Humanities*, 1 (2023), 30–38 <https://doi.org/10.60076/ijstech.v1i1.9>

Susino, Selpia Anggraini, Destiniar Destiniar, and Eka Fitri Puspa Sari, 'The Influence of the Problem Based Learning (PBL) Learning Model on the Mathematical Problem Solving Abilities of Class X High School Students', *Jurnal Cendekia : Jurnal Pendidikan Matematika*, 8 (2023), 53–61

Tauhid, Karimah, Yusuf Safari, and Pina Nurhida, 'Karimah Tauhid, Volume 3 Nomor 9 (2024), e-ISSN 2963-590X', 3 (2024), 9817–24