DOI: https://doi.org/10.33487/edumaspul.v9i1

EDUMASPUL
JURNAL PENDIDIKAN

Vol 09 No. 02 (2025) page 1050-1057

p-ISSN 2548-8201 | e-ISSN 236-0469
https://ummaspul.e-journal.id/maspuljr/

The effect of applying the problem-based learning model on the mathematical problem-solving ability of grade X students at MAS Madinatussalam, Sei Rotan Village

Ersandi Lazuardi[1] , Asmin[2]
ersandilazuardy@gmail.com[1] asminpanjaitan@gmail.com[2]
[12]Universitas Negeri Medan

Receive: 27/07/2025	*Accepted: 01/08/2025*	*Published: 01/10/2025*

Abstrak

Penelitian ini dilakukan bertujuan untuk: (1) mengetahui perbedaan kemampuan matematis siswa sebelum dan setelah diberikan *treatment* dengan menggunakan model pembelajaran *Problem Based Learning* (PBL), (2) mengetahui pengaruh model pembelajaran *Problem Based Learning* terhadap kemampuan pemecahan masalah matematis siswa, (3) mengetahui perbedaan kemampuan pemecahan masalah matematis siswa yang diajarkan dengan model pembelajaran *Problem Based Learning* dengan model pembelajaran Konvensional, (4) mengetahui bagaimana proses jawaban siswa pada *postest* kelas *Problem Based Learning*, dengan desain *pretest-posttest*. Subjek penelitian berjumlah 30 siswa, dan pembelajaran dilaksanakan dalam empat pertemuan. Metode pengumpulan data yang digunakan yakni melalui pretest dan postest kemampuan pemecahan masalah matematis siswa, observasi kegiatan guru, dan observasi aktivitas siswa. Hasil penelitian menunjukkan bahwa: (1) hasil uji *Paired Sample t-test* menunjukkan bahwa nilai t-hitung (4,352) > t-tabel (1,697) dan nilai Sig. (0,000) < (0,05, maka H_0 ditolak dan H_1 diterima artinya terdapat perbedaan rata-rata pada kemampuan pemecahan masalah matematis siswa sebelum dan setelah diterapkan model PBL. (2) hasil uji regresi linier sederhana didaptkan nilai Sig. (0,000) < (0,05) dan t-hitung (4,779) > t-tabel (1,697), H_0 ditolak dan H_1 diterima, artinya bahwa model pembelajaran *Problem Based Learning* berpengaruh signifikan terhadap kemampuan pemecahan masalah matematis siswa, (3) hasil uji *independent sample t-test* terlihat dari nilai t hitung (8,501) > t tabel (1,697) dan nilai Sg. (0,001) < (0,05), maka H_0 ditolak dan H_1 diterima, artinya terdapat perbedaan rata-rata pada kemampuan akhir (postest) pemecahan masalah matematis siswa pada kelas *Problem Based Learning* dan kelas Konvensional, (4) proses jawaban siswa pada tes akhir dengan model PBL menunjukkan bahwa kategori kemampuan pemecahan masalah siswa pada tes akhir sudah pada kategori sangat baik, hal ini terlihat dari nilai rata-rata postest kelas PBL adalah 90. Oleh karena itu, disarankan kepada guru matematika untuk menggunakan model pembelajaran *Problem Based Learning* sebagai upaya untuk meningkatkan kemampuan pemecahan masalah matematis siswa.

Kata Kunci: *Problem Based Learning, Pretest, Postest,* Kemampuan Pemecahan Masalah Matematis siswa, Pembelajaran Matematika

Abstract

This research was conducted with the aim of: (1) knowing the differences in students' mathematical abilities before and after being given treatment using the Problem Based Learning (PBL) learning model, (2) knowing the effect of the Problem Based Learning learning model on students' mathematical problem solving abilities, (3) knowing the differences in students' mathematical problem solving abilities taught with the Problem Based Learning learning model and the Conventional learning model, (4) knowing how the students' answer process was in the Problem Based Learning class posttest, with

a pretest-posttest design. The research subjects were 30 students, and the learning was carried out in four meetings. The data collection methods used were through pretest and posttest of students' mathematical problem solving abilities, observation of teacher activities, and observation of student activities. The results of the study showed that: (1) the results of the Paired Sample t-test showed that the calculated t-value (4.352) > t-table (1.697) and the Sig. value. (0.000) < (0.05, then H_0 is rejected and H_1 is accepted, meaning there is an average difference in students' mathematical problem solving abilities before and after the PBL model is applied. (2) the results of the simple linear regression test obtained a Sig. value (0.000) < (0.05) and t-count (4.779) < t-table (1.697), $H_0$is rejected and H_1 is accepted, meaning that the Problem Based Learning learning model has a significant effect on students' mathematical problem solving abilities, (3) the results of the independent sample t-test can be seen from the calculated t value (8.501) > t table (1.697) and the Sg. value (0.001) < (0.05), then $H_0$is rejected and H_1 is accepted, meaning there is an average difference in the final (posttest) mathematical problem solving abilities of students in the Problem Based Learning class and the Conventional class, (4) the process of students' answers in the final test with the PBL model shows that the category of students' problem-solving abilities in the final test is already in the very good category, this can be seen from the average post-test score of the PBL class which is 90. Therefore, it is recommended for mathematics teachers to use the Problem Based Learning learning model as an effort to improve students' mathematical problem-solving abilities.

***Keywords**: Problem Based Learning, Pretest, Posttest, Students' Mathematical Problem-Solving Ability, Mathematics Learning*

Introduction

Education plays a vital role in the development of a nation. Without proper education, it would be difficult for a country to progress, as education is an essential investment in facing global competition. Therefore, the quality of education must align with advances in science and technology. Education is also a basic human need required to live daily life. Through education, individuals can become better persons, pursue their goals, and achieve happiness through the knowledge they acquire. Hence, education has an important role in creating qualified human resources, one of which is the ability to think critically (Sulistiani & Masrukan, 2016).

Mathematics significantly influences students' education, both in terms of mathematical knowledge and moral development. Mathematics is a branch of knowledge acquired through reasoning, which uses carefully defined terms, clear and precise representations with symbols, and meaningful applications for solving problems related to numbers (Daud, 2017). Therefore, mathematics education not only enhances students' cognitive skills but also contributes to their overall intellectual development.

Problem-solving skills are crucial in helping students think critically, creatively, and independently, while also fostering the development of other mathematical abilities (Hendriana, 2017). In line with this, the International Association for the Evaluation of Educational Achievement (IEA, 2016), through the Trends in International Mathematics and Science Study (TIMSS), reported that Indonesian students scored 45 out of 50 in mathematics proficiency. This result indicates that many Indonesian students still lack adequate mathematical problem-solving skills.

Similarly, the Programme for International Student Assessment (PISA) also highlights Indonesia's persistent challenges in mathematics. According to Zahro and Haerudin (2022), the aim of PISA is "to measure the level of students' ability to use mathematical knowledge and skills in solving real-life problems." However, Indonesia has consistently ranked among the bottom ten countries over the past decade. This poor performance reflects the low level of students' mathematical problem-solving skills at the national level.

To further understand students' mathematical problem-solving abilities, the researcher analyzed the results of the Mid-Semester Examination (UTS) conducted in March 2022. The outcomes served as a benchmark for evaluating whether learning objectives were achieved. This finding is consistent with Arifin (2020), who stated that "the achievement of educational objectives reflects the quality of

education itself." The results demonstrated that many students had not yet reached the expected level of problem-solving ability, pointing to the need for improvements in instructional methods.

Previous studies have shown that the low problem-solving ability of students is caused by various factors. One of the most significant factors influencing students' mathematical problem-solving skills is the learning model applied in the classroom. The use of appropriate learning models is essential because it can make the teaching and learning process more efficient, enhance students' abilities, and help them complete their tasks more effectively (Kuntoro, 2020). Inappropriate or conventional approaches often fail to address students' learning needs.

Problem-Based Learning (PBL) is regarded as one of the effective approaches to address this challenge. PBL emphasizes student-centered learning, where learners are actively involved in analyzing problems, finding solutions, and constructing knowledge. By engaging with real-world problems, students are trained to develop reasoning skills, critical thinking, and creativity, which ultimately improve their mathematical problem-solving skills. Thus, the application of PBL is expected to overcome the limitations of conventional methods and provide meaningful learning experiences for students.

Based on the issues described above, this study aims to evaluate the effect of applying the Problem-Based Learning model on students' mathematical problem-solving ability, particularly in the material of Three-Variable Linear Equations System (SPLTV) for Grade X students at MAS Madinatussalam, Sei Rotan Village. Specifically, this research investigates (1) whether there is a difference in students' problem-solving ability before and after the implementation of PBL, (2) whether PBL has a significant effect on students' mathematical problem-solving skills, (3) whether there is a difference in problem-solving performance between students taught using PBL and those taught using conventional methods, and (4) how students' responses appear in the post-test after learning with PBL. The results of this study are expected to contribute to the development of more effective mathematics learning strategies in schools.

Method

This study employed a quantitative research approach with a quasi-experimental design. The quasi-experimental method was chosen because it allows researchers to examine causal relationships between variables while still considering the limitations of educational settings where true randomization is often not feasible. This design enabled the researcher to measure the effect of the Problem-Based Learning (PBL) model on students' mathematical problem-solving ability by comparing outcomes from both experimental and control groups.

The sampling technique used in this study was purposive sampling. According to Subhaktiyasa (2024), purposive sampling is a technique in which participants are deliberately selected based on specific criteria determined by the researcher. The selected participants met the criteria relevant to the research objectives, particularly Grade X students who were enrolled in mathematics courses at MAS Madinatussalam, Sei Rotan Village. A total of two groups were formed: one experimental group and one control group.

The experimental group was taught using the Problem-Based Learning model, while the control group was taught using a conventional learning model. The PBL class was designed to involve students actively in problem identification, investigation, and solution presentation, whereas the conventional class followed teacher-centered instruction with limited opportunities for students to engage in independent problem-solving. Both groups were exposed to the same content, specifically the topic of Three-Variable Linear Equations System (SPLTV), to ensure comparability of results.

Data collection involved administering pre-tests and post-tests to both groups. The pre-test was conducted to measure students' initial mathematical problem-solving ability before the implementation of the learning models. At the end of the learning intervention, a post-test was conducted to evaluate improvements in students' problem-solving performance. In addition, teacher activity sheets and student activity observations were used to assess the quality and effectiveness of classroom implementation.

The data were analyzed using quantitative statistical techniques with the aid of SPSS version 27. The analysis included classical

assumption tests to ensure the validity of statistical procedures, difference tests (t-tests) to examine mean differences between groups, and N-Gain tests to measure the extent of improvement in students' mathematical problem-solving ability. These analyses provided comprehensive evidence on whether PBL significantly influenced students' performance compared to conventional learning.

The study also established several benchmarks to evaluate the outcomes of the intervention. First, students' mathematical problem-solving ability was considered satisfactory if at least 85% of the students achieved a score of 70 or above. Second, improvement in problem-solving skills was expected to meet at least a moderate category, with N-Gain values ranging from 0.3 to 0.7. Third, teacher performance was assessed through observation sheets, with scores required to fall between 2.6 and 4, categorized as good or very good.

Another important criterion was classroom effectiveness. Effective implementation was indicated when students were highly active in completing group worksheets (LKPD) collaboratively. Such engagement was expected to promote deeper understanding, peer learning, and critical reflection on mathematical concepts. Furthermore, this approach helped ensure that students were not merely passive recipients of knowledge but active constructors of learning.

Finally, the study evaluated whether students were able to solve mathematical problems related to the Three-Variable Linear Equations System accurately and completely according to the established problem-solving indicators. These included the ability to understand the problem, plan a solution, execute the solution correctly, and review the results. The overall outcomes of these indicators provided a comprehensive measure of the effectiveness of the Problem-Based Learning model in improving students' mathematical problem-solving abilities.

Result and Discussion

The learning process in the experimental group using the Problem-Based Learning (PBL) model began with the administration of a pre-test consisting of three questions that measured four indicators of students' mathematical problem-solving ability on the topic of Three-Variable Linear Equations System (SPLTV). The pre-test aimed to determine the students' initial ability before receiving the PBL treatment. Following this stage, the experimental class was taught using the PBL model, which actively engaged students in problem analysis, group discussion, and solution presentation. At the end of the intervention, a post-test with the same set of questions as the pre-test was administered to measure the improvement in students' performance.

During the reflection and evaluation phase, students were asked to discuss what they had learned throughout the lesson. This activity encouraged them to identify difficulties, share strategies, and consolidate their understanding. Such reflective practices are consistent with the principles of PBL, which emphasize not only problem-solving but also metacognitive awareness of the learning process.

The results of the pre-test and post-test for all four problem-solving indicators are summarized in Table 1. The indicators assessed included (1) understanding the problem, (2) planning a solution, (3) solving the problem, and (4) reviewing the solution. The table presents the distribution of students' scores across different categories, ranging from very poor to very good.

Interval	*Pretest* PBL				Kategori	*Postest* PBL				Kategori
	I	II	III	IV		I	II	III	IV	
86-100	17	0	0	0	Sangat Baik	30	30	15	2	Sangat Baik
76 – 85	4	1	0	0	Baik	0	0	8	14	Baik
66 – 75	1	1	0	0	Cukup	0	0	6	6	Cukup
56 – 65	0	8	1	0	Kurang	0	0	1	0	Kurang
0 – 55	8	20	29	30	Sangat Kurang	0	0	0	8	Sangat Kurang

Table 1. Pre-test and Post-test Scores for All Indicators of Students' Mathematical Problem-Solving Ability

Based on Table 1, it was found that students who initially fell into the very poor, poor, and fair categories for each indicator demonstrated significant improvement in their mathematical problem-solving ability. This can be seen from the fact that, in the post-test, no students remained in the very poor category for the indicator of understanding the problem. Similarly, for the indicator of planning a solution, there were no students in the very poor category. Furthermore, only one student remained in the fair category for the indicator of solving the problem, while eight students were still categorized as very poor in the indicator of reviewing their answers. From these findings, it can be concluded that the number of students in the very poor and poor categories decreased substantially. However, in the fourth indicator, many students were still unable to write clear conclusions and solution sets. For students in the very poor, poor, and fair categories, the researcher implemented specific treatments during the learning process to provide additional guidance.

The overall average score of the students in the PBL post-test increased significantly. Prior to the treatment, the students' mathematical problem-solving ability was generally in the very poor category. After the implementation of the PBL model, however, the overall average score rose to 90, which is classified as very good. This finding indicates that the Problem-Based Learning model had a strong positive effect on improving students' mathematical problem-solving abilities.

Based on the results of the paired sample t-test, it was concluded that there was a significant difference in students' mathematical problem-solving ability before and after the implementation of the PBL model. This is evident from the calculated t-value of 4.352, which is greater than the critical t-table value of 1.697, with a significance level of 0.000. Since the significance value is less than 0.05, H0 was rejected and H1 was accepted. This means that there was a significant difference in students' average problem-solving ability before and after the application of the Problem-Based Learning model.

The effect of implementing the PBL model was also confirmed by the results of simple linear regression analysis. The test yielded a significance value of 0.000, which is less than 0.05, and a calculated t-value of 4.779, greater than the t-table value of 1.697. Thus, H0 was rejected and H1 was accepted, indicating that the Problem-Based Learning model had a significant influence on students' mathematical problem-solving ability. To measure the strength of this effect, the coefficient of determination (R-Square) was calculated, resulting in a value of 0.827. When converted into percentage form, this shows that the PBL model contributed 82.7% to students' mathematical problem-solving improvement, while the remaining 17.3% was influenced by external factors such as students' interest, motivation, and other variables beyond the scope of the PBL model.

Furthermore, the independent sample t-test was conducted to compare the post-test results of the experimental (PBL) and control

(conventional) classes. The results showed a significant difference in the final problem-solving ability between the two groups. The calculated t-value was 8.501, which is greater than the t-table value of 1.697, with a significance value of 0.001. Since the significance level is smaller than 0.05, H0 was rejected and H1 was accepted. This indicates that there was a significant difference in students' post-test scores between those taught using the PBL model and those taught using the conventional learning model.

Comparing the two groups, it was evident that the mathematical problem-solving ability of students in the experimental class was higher than that of students in the control class. This improvement occurred because, in the PBL class, the instructional process included steps that guided both individual and group investigations. These steps encouraged students to discover concepts and formulas independently and to retain knowledge for longer periods. Consequently, students in the experimental group became more skilled at analyzing problems and answering questions accurately and effectively.

Table 2. Reviewing Answers in the PBL Class Post-Test

Interval Nilai	Kemampuan Pemecahan Masalah Matematis	Banyak Siswa	Persentase Jumlah Siswa	Rata-Rata Kemampuan Siswa
86 -100	Sangat Baik	2	6%	72% (Cukup)
76 - 85	Baik	14	47%	
66 - 75	Cukup	6	20%	
56 - 65	Kurang	0	0%	
0 - 55	Sangat Kurang	8	27%	
Jumlah Siswa		30 Orang	100%	

For the final test in the PBL class, the average results for each indicator showed considerable improvement. On the first indicator, *understanding the problem*, students achieved an average score of 100%, which was classified as very good. On the second indicator, *planning a solution*, the average score reached 84%, falling into the good category. The third indicator, *solving the problem*, had an average of 86%, which was categorized as very good. Meanwhile, the fourth indicator, *reviewing the solution*, achieved an average of 72%, which was categorized as fair.

The students' responses in solving mathematical problems demonstrated that the implementation of the Problem-Based Learning model led to better outcomes compared to their performance in the pre-test. This improvement could be observed in the structured way students presented their solutions in the final test. Many students were able to correctly identify what was known in the problem, then systematically formulate the mathematical model for the given SPLTV problem. In addition, students showed improvement in solving the problems using appropriate methods and steps. They also displayed the ability to review their answers by writing correct and complete solution sets.

Conclusion

After conducting the study using the Problem Based Learning (PBL) model on the topic of SPLTV to enhance students' mathematical problem-solving abilities, several conclusions can be drawn. The t-test results show a significant difference in students' mathematical problem-solving abilities before and after applying the PBL model, with t-value (4.352) > t-table (1.697) and Sig. (0.000) < 0.05, indicating that the implementation of PBL effectively improves students' problem-solving skills.

The simple linear regression analysis further confirms that the PBL model has a significant effect on students' mathematical problem-solving ability, with t-value (4.779) > t-table (1.697), Sig. (0.000) < 0.05, and an R-Square value of 0.827, showing that 82.7% of the improvement in problem-solving ability can be attributed to the PBL model. Additionally, the independent sample t-test shows a significant difference in post-test scores between the PBL class and the Conventional class (t-value 8.501 > t-table 1.697, Sig. 0.001 < 0.05), demonstrating the superiority of PBL over traditional methods.

Observations of students' final test responses also reveal a marked improvement in structured and clear problem-solving. Most students were able to understand problems, plan solutions, execute steps accurately, and review answers systematically. For instance, in the PBL class, the majority of students performed at "very good" or "good" levels across the indicators of

understanding the problem, planning, solving, and reviewing, indicating that PBL not only enhances mathematical ability but also promotes systematic thinking and problem-solving strategies.

References

Lazuardi, E., & Asmin. (2025). The effect of applying the Problem-Based Learning model on the mathematical problem-solving ability of grade X students at MAS Madinatussalam, Sei Rotan Village. Universitas Negeri Medan.

Alashwal, H. A. (2025). A mixed-methods exploration of its long-term effects on students' mathematical problem-solving abilities in primary education. ScienceDirect.

Choirunisa, et al. (2024). Transforming Mathematical Problem Solving Through AI Tools: An Investigation of Photomath Integration in Problem-Based Learning. Journal of Education and Learning Mathematics Research, 5(2), 152–160.

Dewi, Y. P. C. (2025). The Influence of PBL Learning Model on High School Students' Learning Outcomes in Mathematics. International Journal of Research in Education and Science, 11(3), 3582–2032.

Hendriana, H., Johanto, T., & Sumarmo, U. (2018). The role of problem-based learning to improve students' mathematical problem-solving ability and self-confidence. Journal on Mathematics Education, 9(2), 291–300.

Hendriana, H., & Soemarmo, U. (2014). Penilaian pembelajaran matematika. Refika Aditama.

Hermansyah, S., & Hasan, H. (2020). Exploring the Impact of English Movies to Improve the Students' Listening Comprehension. *Maspul Journal of English Studies*, *2*(2), 32-36. https://doi.org/10.33487/majesty.v2i2.586

Jonassen, D. H. (2011). Supporting problem solving in PBL. Interdisciplinary Journal of Problem-based Learning, 5(2), 95–119.

Karatas, I., & Baki, A. (2017). The effect of learning environments based on problem solving on students' achievements of problem solving. International Electronic Journal of Elementary Education, 5(3), 249–268.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. Educational Psychologist, 41(2), 75–86.

Lazuardi, E., & Asmin. (2025). The effect of applying the Problem-Based Learning model on the mathematical problem-solving ability of grade X students at MAS Madinatussalam, Sei Rotan Village. Universitas Negeri Medan.

Montague, M., Krawec, J., Enders, C., & Dietz, S. (2014). The effects of cognitive strategy instruction on math problem solving of middle-school students of varying ability. Journal of Educational Psychology, 106(2), 469–481.

Mudrikah, A. (2016). Problem-based learning associated by action-process-object-schema (APOS) theory to enhance students' high order mathematical thinking ability. International Journal of Research in Education and Science, 2(1), 125–135.

Mukhlis, M. (2023). Higher-Order Thinking Skills Through Problem-Based Learning in Solving SPLTV Questions. Atlantis Press.

Novita, R., & Putra, M. (2016). Using task like PISA's problem to support student's creativity in mathematics. Journal on Mathematics Education, 7(1), 31–42.

Özsoy, G., & Ataman, A. (2017). The effect of metacognitive strategy training on mathematical problem solving achievement. International Electronic Journal of Elementary Education, 1(2), 67–82.

Padmavathy, R. D., & Mareesh, K. (2013). Effectiveness of problem based learning in mathematics. International Multidisciplinary e-Journal, 2(1), 45–51.

Polya, G. (1985). How to Solve It: A New Aspect of Mathematical Method (2nd ed.). Princeton University Press.

Rustella, F., & Chotimah, S. (2023). Analysis of students' mathematical problem-solving ability in solving statistics problems based on the ability level of grade VIII junior high school students. Journal of Innovative Mathematics Learning, 6(4), 1737–1746.

Salsabila, S. (2024). The Effect of Problem-Based Learning Models on Students' Mathematical Problem-Solving Abilities: A Meta-Analysis. Journal of Mathematics and Science Education, 5(1), 89–102.

Sam Hermansyah, Syamsu T, Syamsunir, Winda Pratiwi, K., Hamka, N., & Ramli, R. (2025). Improvement of Vocational Skills of SMK Muhammadiyah Rappang Students Through an Entrepreneurship-Based Training Program in Pancarijang District, Sidenreng Rappang Regency . *Unram Journal of Community Service*, *6*(2), 326–333. https://doi.org/10.29303/ujcs.v6i2.987

Shongwe, B. (2024). The effect of STEM problem-based learning on students' mathematical problem-solving beliefs. Eurasia Journal of Mathematics, Science and Technology Education, 20(8), em2486.

Mushlihuddin, R. (2018). The effectiveness of problem-based learning on students' mathematical problem-solving abilities in vector analysis courses. Journal of Physics: Conference Series, 948(1), 102028.