

IMPLEMENTATION OF THE PROBLEM-BASED LEARNING MODEL TO IMPROVE JUNIOR HIGH SCHOOL STUDENTS' MATHEMATICAL NUMERACY LITERACY

¹⁾Friska Ledina Situngkir, ²⁾Jesika Simorangkir, ³⁾Veronika Vanny Zay

^{1 2 3)} Saint Thomas Catholic University of Medan
Email: friskaledina12321@gmail.com

*Correspondence Author: friskaledina12321@gmail.com

Article Info

Keywords:

Problem-Based Learning, mathematical numeracy literacy, mathematics education, classroom action research.

ABSTRACT

Mathematics learning is frequently perceived as challenging by students due to the abstract nature of mathematical concepts and the limited integration of real-life contexts into classroom instruction. Consequently, there is a need for instructional approaches that effectively foster students' mathematical numeracy literacy and higher-order thinking skills. This study aimed to improve students' mathematical numeracy literacy through the implementation of the Problem-Based Learning (PBL) model. The study employed a Classroom Action Research (CAR) design conducted at Budi Murni 3 Junior High School, Medan, involving 30 eighth-grade students as research participants. The research was implemented in two action cycles, each consisting of four stages: planning, action, observation, and reflection. Data were collected using mathematical numeracy achievement tests and student activity observation sheets. The findings revealed that the implementation of the PBL model significantly enhanced students' mathematical numeracy literacy. The mean achievement score increased from 54 in the pre-action phase to 70 in Cycle I and further improved to 82 in Cycle II. Learning mastery also increased substantially from 26.7% to 86.7%. In addition, students' learning activities improved from 66.5% in Cycle I to 81.25% in Cycle II, indicating greater engagement throughout the learning process. These findings suggest that the Problem-Based Learning model is effective in improving students' mathematical numeracy literacy and promoting active participation in mathematics learning.

Article Information

Keywords:

Problem-Based Learning, numeracy literacy, mathematics learning, CAR

ABSTRACT

Abstract

Mathematics learning is often considered difficult by students because the concepts are abstract and insufficiently related to real-life experiences. Therefore, a learning model is needed that can improve students' critical thinking skills and numeracy literacy. This study aimed to improve students' mathematical numeracy literacy through the implementation of the Problem-Based Learning (PBL) model. This study was classroom action research conducted at Budi Murni 3 Junior High School, Medan, involving 30 eighth-grade students as research subjects. The research was conducted in two cycles, each consisting of the stages of planning, action implementation, observation, and reflection. Data were collected using learning achievement tests and student activity observation sheets. The results showed that the implementation of the Problem-Based Learning model was able to improve students' mathematical numeracy literacy. The students' mean score increased from 54 in the pre-action phase to 70 in Cycle I and further increased to 82 in Cycle II. The percentage of learning mastery increased from 26.7% to 86.7%. Student learning activities also increased from 66.5% in Cycle I to 81.25% in Cycle II. Thus, it can be concluded that the Problem-Based Learning model is effective in improving students' mathematical numeracy literacy.

Article History

Received : 18/05/2026
Revised : 09/06/2026
Accepted : 12/07/2026

✉ **Corresponding Author:** (1) Friska Ledina Situngkir, (2) Saint Thomas Catholic University of Medan, (3) Medan, Indonesia, (4) Email: friskaledina12321@gmail.com

Introduction

Mathematics is one of the subjects that plays an important role in developing students' logical, critical, and systematic thinking skills. Through mathematics learning, students are expected to develop problem-solving skills and be able to apply mathematical concepts in everyday life (Hudojo, 2005). However, in practice, many students still experience difficulties in understanding mathematical concepts because learning tends to be abstract and is insufficiently related to real-life contexts. One important skill in mathematics learning is numeracy literacy. Numeracy literacy is an individual's ability to understand and use mathematical concepts in various life situations (OECD, 2019). This ability is very important because it helps students make data-based decisions and solve various problems in everyday life.

The results of the Programme for International Student Assessment (PISA) show that Indonesian students' numeracy literacy skills are still relatively low compared with those of other countries (OECD, 2019). This indicates that the mathematics learning process needs to be improved so that students are not only able to solve problems procedurally but also able to understand mathematical concepts deeply. One cause of students' low numeracy literacy skills is the teacher-centered learning method. Teacher-centered learning causes students to become less active in the learning process (Arends, 2012). Therefore, a learning model is needed that can encourage students to think critically and be actively involved in the learning process. One learning model that can be used to improve students' problem-solving and numeracy literacy skills is Problem-Based Learning (PBL). The Problem-Based Learning model is a learning model that uses real problems as a context for students to learn critical thinking and problem solving (Hmelo-Silver, 2004).

According to Savery (2006), Problem-Based Learning is a student-centered learning approach in which students learn through the process of investigating a problem. Through problem-based learning, students can develop critical thinking skills, collaboration skills, and problem-solving skills. Research conducted by Hmelo-Silver (2004) shows that Problem-Based Learning can improve students' critical thinking skills and conceptual understanding. In addition, research by Yew & Goh (2016) also shows that problem-based learning can increase student engagement in the learning process. In the context of mathematics learning, the Problem-Based Learning model provides students with the opportunity to relate mathematical concepts to real-world problems, making learning more meaningful (Polya, 1973). Through group discussion and problem investigation, students can develop higher-order thinking skills (Higher Order Thinking Skills).

Previous research indicates that Problem-Based Learning has a positive effect on students' mathematics learning outcomes. A study by Siregar (2020) showed that

the implementation of the PBL model can improve students' mathematical problem-solving skills. Another study by Ningsih (2019) also showed that Problem-Based Learning can improve students' critical thinking skills. In addition to improving problem-solving skills, Problem-Based Learning can also increase students' learning activities. According to Arends (2012), problem-based learning encourages students to actively participate in discussions, express opinions, and seek solutions to the problems presented. Thus, the implementation of Problem-Based Learning is expected to improve students' mathematical numeracy literacy. Based on the description above, the purpose of this study is to determine the improvement in students' mathematical numeracy literacy through the implementation of the Problem-Based Learning model.

Research Method

This study is a Classroom Action Research (CAR) study based on the Kemmis and McTaggart model, which includes four stages: planning, action implementation, observation, and reflection. The study was conducted at SMP Budi Murni 3 Medan among 30 eighth-grade students in the 2025/2026 academic year. The action was carried out in two cycles, with each cycle consisting of two meetings implementing the Problem-Based Learning (PBL) model through the stages of problem orientation, student organization, individual and group investigation, presentation of results, and analysis and evaluation of the problem-solving process. Research data were collected using mathematical numeracy literacy tests and student learning activity observation sheets. Test data were analyzed descriptively and quantitatively by calculating mean scores and the percentage of learning mastery, while observation data were analyzed based on the percentage of student activity during the learning process. The action was considered successful if at least 85% of students achieved learning mastery and student learning activity was in the active category, as indicated by improvements in student learning outcomes and activities in each cycle.

Research Results

The research results showed that the implementation of the *Problem-Based Learning* (PBL) model was able to improve the mathematical literacy and numeracy skills of eighth-grade students at SMP Budi Murni 3 Medan. This improvement was evident from students' learning test results, learning activities, and the percentage of learning mastery in each research cycle.

Pre-Action Results

At the pre-action stage, initial observations and a pretest were conducted to determine students' initial abilities before the Problem-Based Learning model was implemented. The observation results showed that learning was still teacher-centered, resulting in students being less active in the learning process. In addition, students' ability to understand problem-based questions

was still low. Based on the pretest results, the students' mean score was 54, with the highest score of 72 and the lowest score of 40. Of the 30 students, only 8 achieved learning mastery, representing a mastery percentage of 26.7%. These results indicate that students' mathematical literacy and numeracy skills were still low, so remedial action was needed in the learning process.

Cycle I Results

Cycle I was implemented by applying the steps of Problem-Based Learning, namely presenting contextual problems, group discussion, problem investigation, presentation of discussion results, and drawing conclusions together. Based on the observation results of student activities in Cycle I, the average learning activity was 66.5%, categorized as adequate. Students began to actively participate in discussions and attempted to understand the problems presented, although some students still appeared passive in expressing their opinions. The Cycle I posttest results showed an improvement compared with the pre-action stage. The students' mean score increased to 70, with a learning mastery percentage of 60%. The number of students who achieved mastery increased to 18. However, these results

Improvement in Student Learning Outcomes

The improvement in student learning outcomes in each cycle can be seen in the following table:

Table 1. Improvement in Learning Outcomes in Each Cycle

Stage	Mean	Mastery
Pre-intervention	54	26,7%
Cycle I	70	60%
Cycle II	82	86,7%

Based on the table, it can be seen that students'

Discussion

Based on the research findings, the implementation of the Problem Based Learning (PBL) model was proven to improve the mathematical literacy and numeracy skills of eighth-grade students at SMP Budi Murni 3 Medan. This improvement was reflected in students' learning outcomes in each research cycle, in which the students' average score increased from 54 at the pre-intervention stage to 70 in Cycle I and increased again to 82 in Cycle II. The percentage of learning mastery also increased significantly, from 26.7% in the pre-intervention stage to 60% in Cycle I and reaching 86.7% in Cycle II. The improvement in learning outcomes indicates that the Problem Based Learning model can create more meaningful learning because students are actively involved in the problem-solving process. This is in line with research by Rahmadani (2019), which stated that problem-based learning can improve students' critical thinking skills and understanding of mathematical concepts. In addition, research by Sari and Mulyono (2020) in a SINTA-indexed journal explained that PBL provides students with opportunities to construct their own

had not yet reached the study's success indicator, namely that 75% of students achieved a score of ≥ 75 . Therefore, the study was continued in Cycle II by making several improvements to the learning process.

Cycle II Results

In Cycle II, improvements to instruction were made based on the reflection results from Cycle I. The teacher provided more intensive guidance to students during group discussions and clarified the steps of Problem-Based Learning so that students could better understand the learning process. The observation results of student activities in Cycle II showed a significant improvement. The average student learning activity increased to 81.25%, categorized as good. Students appeared more active in discussions, asking questions, expressing opinions, and presenting the results of group discussions. The Cycle II posttest results also showed a very good improvement. The students' mean score increased to 82, with the highest score of 92 and the lowest score of 70. The number of students who achieved learning mastery increased to 26, with a mastery percentage of 86.7%. These results indicate that the study's success indicators had been achieved; therefore, the study was concluded in Cycle II.

learning outcomes improved gradually in each cycle. This improvement indicates that the implementation of the Problem Based Learning model was able to help students better understand mathematical concepts and improve their numeracy literacy skills. In addition to learning outcomes, students' learning activities also improved during the learning process. Student activity increased from 66.5% in Cycle I to 81.25% in Cycle II. This indicates that problem-based learning can increase students' active participation in mathematics learning.

knowledge through contextual learning experiences.

At the pre-intervention stage, students' abilities were still relatively low because the learning employed tended to be teacher-centered, resulting in students being less active in independently discovering concepts. This condition caused students to experience difficulties in understanding numeracy literacy-based questions. After the Problem Based Learning model was implemented, students began to become accustomed to analyzing problems, discussing them in groups, and seeking solutions to the problems provided. These activities enabled students to understand mathematical concepts more deeply. This finding is consistent with the study by Setiyani, & Winanto, A. (2024), which stated that the PBL model can improve students' mathematical problem-solving abilities because students are trained to think systematically and critically.

The improvement in learning outcomes in Cycle I indicated that students began to adapt to problem-based learning. However, several students still appeared passive in group discussions and lacked confidence in expressing their opinions. Therefore, improvements were made in

Cycle II by increasing teacher guidance and managing group discussions more effectively. As a result, students' activities and learning outcomes improved further. This indicates that the success of PBL implementation is influenced by the teacher's ability to facilitate the learning process. Research conducted by Putra and Fitriani (2022) also stated that the teacher's role as a facilitator is crucial to the success of problem-based learning.

In addition to improving learning outcomes, the implementation of Problem Based Learning was also able to increase students' learning activities during the learning process. Based on the results of observations of student activity, the average learning activity increased from 66.5% in Cycle I to 81.25% in Cycle II. This increase in activity was evident in the aspects of active questioning, discussion skills, group collaboration, and confidence in expressing opinions. The Problem Based Learning model provides students with opportunities to be more active in learning because students do not merely receive information from the teacher but are also directly involved in the process of finding solutions to the problems provided. This is consistent with Wahyuni's (2020) view that PBL can increase students' active participation in mathematics learning through group discussion and investigation activities.

The increase in students' learning activities also indicates that the PBL model can create a more interactive and enjoyable learning atmosphere. When students are given problems related to everyday life, they become more interested and motivated to participate in learning. Research by Nugraheni (2021) explained that the use of contextual problems in mathematics learning can increase students' learning motivation because students perceive that learning is connected to real life. Students' numeracy literacy skills also improved after the implementation of Problem Based Learning. In problem-based learning, students are trained to understand information, analyze data, and use mathematical concepts to solve contextual problems. These skills are an important part of numeracy literacy. Research by Akas et al. (2025) stated that students' numeracy literacy can develop through learning that emphasizes critical thinking and problem-solving skills.

The results of this study also support previous research conducted by Hidayat (2019), which stated that Problem Based Learning is effective in improving junior high school students' mathematical literacy skills. In addition, research by Pratiwi and Susanti (2021) showed that students who learned using the PBL model had better numeracy skills than students who learned using conventional methods. The increase in learning mastery from 26.7% to 86.7% indicates that most students achieved the established success indicators. This proves that Problem Based Learning can help students better understand mathematics material. Research by Sembiring (2022) also showed that consistent implementation of PBL

can improve mathematics learning outcomes and students' higher-order thinking skills.

During the learning process, students appeared more confident in expressing their opinions and more active in collaborating within groups. These activities indicate that problem-based learning not only improves students' cognitive aspects but also their social and communication skills. Research by Lestari (2020) states that problem-based learning can improve students' mathematical communication skills through presentation activities and group discussions. In addition, the implementation of PBL also trains students to think critically in solving mathematical problems. Students do not focus solely on the final answer but also understand the problem-solving process. This is consistent with research by Ramadhani and Nasution (2024), which states that Problem Based Learning can improve students' mathematical critical thinking skills because students are trained to analyze and evaluate various alternative solutions to problems.

The successful implementation of Problem Based Learning in this study indicates that student-centered learning models are more effective than conventional learning. Through PBL, students become more active, independent, and able to develop their numeracy literacy skills optimally. Research by Yuliana (2025) also states that problem-based learning is highly relevant for implementation in 21st-century mathematics learning because it can develop students' higher-order thinking skills and collaborative abilities. Thus, it can be concluded that the implementation of the Problem Based Learning model can improve the mathematical literacy and numeracy skills of eighth-grade students at SMP Budi Murni 3 Medan. This improvement can be seen in students' learning outcomes, learning mastery, and learning activities, all of which increased in each research cycle. The findings of this study reinforce various previous studies stating that Problem Based Learning is an effective learning model for improving the quality of mathematics learning.

Conclusion

Based on the research findings and discussion, it can be concluded that the *implementation of the* Problem Based Learning (PBL) model can improve the mathematical literacy and numeracy skills of eighth-grade students at SMP Budi Murni 3 Medan. This improvement was evident in students' learning outcomes in each research cycle. At the pre-action stage, the students' average score was only 54, with a learning mastery percentage of 26.7%. After the Problem Based Learning model was implemented in Cycle I, the students' average score increased to 70, with a mastery percentage of 60%. Furthermore, in Cycle II, the students' average score increased again to 82, with the learning mastery percentage reaching 86.7%. These results indicate that the research success indicators were achieved because more

than 75% of students obtained scores ≥ 75 . In addition to improving learning outcomes, the Problem Based Learning model was also able to increase students' learning activities. Student activity increased from 66.5% in groups during the learning process. Thus, it can be concluded that the implementation of the Problem Based Learning model is effective for improving students' mathematical literacy and numeracy in mathematics learning.

Acknowledgments

We would like to thank the principal and students of SMP Budi Murni 3 Medan, the students who contributed to assisting with the research and journal preparation, and all parties who participated in supporting this research.

References

- [1] Arends, R. I. (2012). *Learning to Teach* (9th ed.). New York, NY: McGraw-Hill Education.
- [2] Akas, A., Pujiastuti, H., & Rafianti, I. (2025). The effect of problem-based learning on junior high school students' mathematical literacy skills in terms of learning styles. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 9(2), 527–538. <https://doi.org/10.31004/cendekia.v9i2.3937>
- [3] Setiyani, & Winanto, A. (2024). Improving mathematical problem-solving skills through the problem-based learning model with a culturally responsive teaching approach. *Jurnal Belaindika: Pembelajaran dan Inovasi Pendidikan*, 6(2), 205–215.
- [4] Hidayat, A. (2019). The effectiveness of problem-based learning on junior high school students' mathematical literacy skills. *Jurnal Pendidikan Matematika Indonesia*, 4(2), 78–85.
- [5] Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235–266. <https://doi.org/10.1023/B:EDPR.0000034022.16470.f3>
- [6] Hudojo, H. (2005). *Curriculum Development and Mathematics Learning*. Malang: Universitas Negeri Malang.
- [7] Lestari, D. (2020). The effect of the problem-based learning model on students' mathematical communication skills. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, 9(4), 1120–1130.
- [8] Ningsih, S. (2019). The effect of problem-based learning on students' critical thinking skills. *Jurnal Pendidikan Matematika*, 3(2), 95–102.
- [9] Nugraheni, S. (2021). Problem-based contextual learning in improving students' motivation to learn mathematics. *Jurnal Pendidikan Matematika Raflesia*, 6(1), 55–66.
- [10] OECD. (2019). *PISA 2018 Results: What Students Know and Can Do*. Paris: OECD Publishing. <https://doi.org/10.1787/5f07c754-en>
- [11] Polya, G. (1973). *How to Solve It*. Princeton, NJ: Princeton University Press.
- [12] Pratiwi, R., & Susanti, E. (2021). Students' numeracy skills through the implementation of problem-based learning. *Jurnal Elemen*, 7(2), 240–252.
- [13] Putra, A., & Fitriani, D. (2022). The role of teachers in implementing problem-based learning in mathematics education. *Jurnal Pendidikan Tambusai*, 6(1), 3300–3310.
- [14] Rahmadani, Y. (2019). The effect of problem-based learning on students' mathematical critical thinking skills. *Jurnal Pendidikan Matematika*, 8(1), 44–53.
- [15] Ramadhani, F., & Nasution, H. (2024). The implementation of problem-based learning in improving junior high school students' mathematical critical thinking skills. *Jurnal Cendekia*, 8(1), 101–114.
- [16] Sari, M., & Mulyono, M. (2020). The implementation of problem-based learning in secondary school mathematics education. *Jurnal Pendidikan Matematika Indonesia*, 5(2), 91–99.
- [17] Savery, J. R. (2006). Overview of problem-based learning: Definitions and distinctions. *Interdisciplinary Journal of Problem-Based Learning*, 1(1), 9–20. <https://doi.org/10.7771/1541-5015.1002>
- [18] Sembiring, R. (2022). Effectiveness of the problem-based learning model on junior high school students' mathematics learning outcomes. *Jurnal Pendidikan dan Konseling*, 4(5), 2230–2238.
- [19] Wahyuni, E. (2020). Student learning activities through the implementation of problem-based learning in mathematics instruction. *Jurnal Basicedu*, 4(4), 1150–1158.
- [20] Yew, E. H. J., & Goh, K. (2016). Problem-based learning: An overview of its process and impact on learning. *Health Professions Education*, 2(2), 75–79. <https://doi.org/10.1016/j.hpe.2016.01.004>
- [21] Yuliana, N. (2025). Problem-based learning as a 21st-century learning strategy in mathematics. *Jurnal Edukasi Matematika dan Sains*, 13(1), 1–12.