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Enhancing Literacy, Numeracy, and Mathematics Learnig Motivation Using the Problem-Based Learning Model

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Abstrak

Kemampuan literasi numerasi dipengaruhi oleh berbagai faktor, salah satunya adalah rendahnya minat belajar siswa yang dapat menurunkan motivasi dan selanjutnya berdampak pada kemampuan berpikir kritis serta pemecahan masalah matematis. Penelitian ini bertujuan untuk mengimplementasikan model Problem-Based Learning (PBL) guna meningkatkan literasi, numerasi, dan motivasi belajar matematika siswa. Penelitian ini menggunakan desain Penelitian Tindakan Kelas yang terdiri atas tiga siklus, masing-masing meliputi tahap perencanaan, pelaksanaan, observasi, dan refleksi. Modul ajar, lembar kerja peserta didik, dan instrumen evaluasi dikembangkan dan disempurnakan secara sistematis pada setiap siklus. Subjek penelitian adalah 25 siswa kelas IX-E SMPN 4 Tarogong Kidul yang dipilih melalui teknik purposive sampling. Pengumpulan data dilakukan melalui tes tertulis, observasi, dan angket. Analisis data mengombinasikan statistik deskriptif dalam bentuk persentase dan analisis deskriptif kualitatif, yang meliputi reduksi data, penyajian data secara sistematis melalui narasi dan tabel, serta penarikan kesimpulan. Hasil penelitian menunjukkan adanya peningkatan yang substansial pada kemampuan literasi dan numerasi siswa, dengan 68% siswa menunjukkan perkembangan yang terukur disertai peningkatan motivasi belajar. Meskipun capaian tersebut belum sepenuhnya memenuhi indikator keberhasilan yang ditetapkan sebesar 70%, peningkatan yang diperoleh menunjukkan bahwa penerapan model PBL memberikan dampak yang bermakna dan positif terhadap pembelajaran matematika siswa.

***Kata Kunci**: Literasi; Numerasi; Motivasi Belajar; Matematika; Problem Based Learning.*

Abstract

Numeracy literacy skills are influenced by various factors, one of which is low student interest, which can reduce learning motivation and subsequently affect critical thinking and mathematical problem-solving abilities. This study aims to implement the Problem-Based Learning (PBL) model to enhance students' literacy, numeracy, and motivation in learning mathematics. The research employed a classroom action research design consisting of three cycles, each including planning, implementation, observation, and reflection stages. Teaching modules, student worksheets, and evaluation instruments were systematically developed and refined in each cycle. The subjects were 25 students from class IX-E at SMPN 4 Tarogong Kidul, selected through purposive sampling. Data were collected using written tests, observations, and questionnaires. Data analysis combined descriptive statistics in the form of percentages and qualitative descriptive analysis, including data reduction, systematic presentation of findings through narratives and tables, and conclusion drawing. The results showed a substantial improvement in students' literacy and numeracy skills, with 68% of students demonstrating measurable progress, accompanied by increased learning motivation. Although the outcome did not fully reach the predetermined 70% success indicator, the observed gains indicate that the implementation of the PBL model had a meaningful and positive impact on students' mathematics learning.

Keywords: Literacy; Numeracy; Learning Motivation; Mathematics; Problem-Based Learning.

I. INTRODUCTION

Education is a learning process that includes the development of knowledge, skills, and values aimed at shaping an individual's character, intelligence, and abilities. Education is not limited to formal classroom settings but can also be acquired through experiences and interactions with social, cultural, and technological environments (Daryanto, 2017; Sarumaha, Khairiani, & Amirah, 2025). Education must be able to respond to the challenges of the times by developing 21st-century skills, such as critical thinking, creativity, communication, and collaboration. Mathematics, as a product of human thought, involves concepts, processes, and essential reasoning (Kusmawardani, 2018; Ardiansyah & Wahyuningrum, 2022). Therefore, mathematics plays a crucial role in the advancement of modern technology and human resource development. This is why education in Indonesia places mathematics as a core component of the curriculum at all levels, including Junior High School (SMP). The primary goal of mathematics education is to equip students with a strong understanding of mathematical concepts and the ability to apply mathematics in everyday life (Kamarullah, 2017; Hasanudin & Maryati, 2023).

In the 21st century, students are expected to master three main competencies: character qualities, competencies, and literacy. To achieve these competencies, thinking and reasoning skills are essential for problem-solving. These skills are closely related to literacy. In 2015, the World Economic Forum identified six essential literacy types: reading literacy, numeracy literacy, scientific literacy, digital literacy, financial literacy, and cultural and civic literacy. One type of literacy that is strongly related to thinking and reasoning skills is numeracy literacy. Literacy relates to language, while numeracy relates to mathematics; thus, numeracy literacy is the ability to reason using language and mathematics.

Numeracy literacy refers to students' ability to interpret information related to numbers or mathematics, formulate problems, analyze issues, and find solutions to those problems (Maulidina & Hartatik, 2019; Jayanti & Cesaria, 2024). This skill is crucial in mathematics because mathematics is not just about formulas but also requires critical thinking skills to solve problems. Numeracy literacy also helps students understand the role of mathematics in solving real-life problems.

Literacy and numeracy are skills used to apply numbers and basic mathematical symbols in solving practical problems encountered in daily life, as well as the ability to analyze information presented in graphs, tables, and charts. The results of this analysis are used to make predictions and decisions. There are six main components of numeracy literacy: (1) counting and estimating whole numbers, (2) understanding and using fractions, decimals, percentages, and ratios, (3) recognizing and applying patterns and relationships, (4) using spatial reasoning, (5) utilizing measurement, and (6) interpreting statistical information (Wahyudy & Muqodas, 2019; Tito, Muhtadi, & Sukirwan, 2024). In Indonesia, numeracy literacy is reflected in international assessments such as PISA

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(Program for International Student Assessment), which measures students' ability to solve mathematical problems and apply mathematical concepts to real-world situations. High numeracy literacy helps students think more critically and creatively when facing mathematical challenges and increases their motivation to deepen their understanding of mathematics.

Recent data from the *Programme for International Student Assessment* (PISA) 2022 indicate that Indonesian students' mathematics literacy remains significantly below the OECD average (Qolbi & Afriansyah, 2024). Indonesia obtained an average mathematics score of 366, compared to the OECD average of 472. This result shows that most Indonesian students have not yet reached the minimum level of mathematical proficiency, as only about 18% of students achieved at least Level 2 in mathematics, far below the OECD average of 69%. These findings reflect students' difficulties in interpreting real-world situations mathematically and solving context-based problems that require numeracy skills.

One factor contributing to this condition is the predominance of conventional teaching approaches that are largely lecture-based and teacher-centered. Such approaches tend to emphasize procedural knowledge and formula memorization rather than conceptual understanding, critical thinking, and the application of numeracy in real-life contexts. As a result, students have limited opportunities to actively engage in meaningful problem solving and reflective learning processes, which are essential for developing analytical, evaluative, and mathematical modeling skills assessed in large-scale evaluations such as PISA. Therefore, a shift toward more student-centered and contextual learning models, such as Problem-Based Learning (PBL), is considered necessary to provide authentic problem-solving experiences and to enhance students' engagement and motivation in mathematics learning.

Besides literacy and numeracy, an essential affective aspect in mathematics learning is learning motivation. Motivation is an internal drive that pushes an individual to achieve goals. In the context of mathematics learning, motivation is often influenced by factors such as self-confidence, interest in the subject, and the relevance of mathematical concepts to real life. High motivation has a positive impact on learning success, as motivated students tend to be more engaged in the learning process and adapt more easily to challenges.

Mathematics is often perceived as a difficult subject, leading to low student motivation. This usually occurs when students feel that the material taught has no relevance to their lives or is too abstract to understand. Therefore, it is crucial to enhance students' numeracy literacy, as it not only helps them grasp mathematical concepts more easily but also builds their confidence and motivation to learn mathematics further. Indicators of learning motivation include (1) having the drive and desire to achieve success, (2) having the urge and need to learn, (3) having hopes and goals for the future, (4) receiving rewards from the learning process, (5)

engaging in interesting learning activities, and (6) having a supportive learning environment (Rahman, 2022).

One learning model that can enhance students' literacy, numeracy, and learning motivation is the Problem-Based Learning (PBL) model. This model provides students with opportunities to engage in real-world problem-solving, encouraging them to think critically and creatively (Sumartini, 2016; Rinaldi & Afriansyah, 2019; Aisha & Adirakasiwi, 2025). It also enhances learning motivation by providing direct experiences relevant to students' lives. Problem-Based Learning is particularly suitable for improving students' numeracy literacy, as its learning process incorporates various indicators of numeracy literacy skills, including students working effectively in real-life situations, using thinking skills, and connecting information with real-world contexts (Ambarwati & Kurniasih, 2021).

The PBL model provides a more realistic experience because the material taught is linked to students' real lives (Sari, 2020). PBL is a learning model in which students attempt to solve problems through a series of steps based on scientific methods, allowing them to apply acquired knowledge and develop problem-solving skills (Syamsidah & Suryani, 2018). According to Duch (Widayanti & Nur'aini, 2020), the key characteristic of the PBL model is the use of real-world problems relevant to students' lives, encouraging them to think critically, solve problems, and acquire adaptable knowledge from the problems they face. Furthermore, the PBL model provides opportunities for students to solve problems encountered in the learning process (Wahyuningsih, 2019). Based on these expert opinions, it can be concluded that PBL is an effective learning model for teaching mathematics.

According to John Dewey (Syamsidah & Suryani, 2018), the Problem-Based Learning (PBL) model consists of several sequential stages. These stages include directing students to identify the problem to be addressed with guidance from the teacher, organizing students to explore and analyze the problem from their own perspectives, facilitating individual and collaborative investigations to gather relevant information, encouraging students to present and discuss their proposed solutions, and finally guiding students to reflect on and evaluate both the problem-solving process and the outcomes achieved.

Based on this framework, the present study seeks to investigate the implementation of the Problem-Based Learning (PBL) model as an instructional approach to enhance students' literacy, numeracy, and learning motivation in mathematics. Through the application of this model, the study expects to contribute effective strategies for improving the overall quality of mathematics education in schools.

II. METHOD

This study is a Classroom Action Research (CAR) aimed at improving students' literacy, numeracy, and motivation in learning mathematics through the implementation of the Problem-Based Learning (PBL) model. The CAR is conducted in cycles, with each cycle comprising the stages of planning, implementing actions, observation, and

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reflection. This research was carried out at SMPN 4 Tarogong Kidul, with the research subjects being 25 students from class IX-E. The selection of subjects was done using purposive sampling, choosing a class with literacy, numeracy, and learning motivation levels that needed improvement.

Data collection was conducted by evaluating students' work through worksheets (LKPD) and observing students during the learning process using an assessment rubric for attitudes and group work. The success benchmark for this study was determined based on students' systematic problem-solving and correct calculations. If more than 50% of students achieved this, it was considered a sufficient improvement, whereas if it exceeded 85%, it was categorized as a significant improvement.

The research procedure consists of four recurring activities in cycles: (1) planning, (2) action, (3) observation, and (4) reflection (Arikunto et al., 2021). Data were collected using various methods to ensure validity and reliability, including:

1. Written tests to measure improvements in students' literacy and numeracy skills.
2. Observations to assess student engagement in PBL-based learning.
3. Questionnaires to measure students' motivation levels before and after the intervention.

The data analysis was conducted both qualitatively and quantitatively, following these steps:

1. Data Reduction: Filtering relevant data related to improvements in students' literacy, numeracy, and learning motivation.
2. Data Presentation: Organizing findings systematically and logically in the form of tables, graphs, and narrative descriptions.
3. Conclusion Drawing: Determining the effectiveness of the PBL model in enhancing students' abilities based on the collected data.

This study is considered successful if it meets the following criteria:

- At least 70% of students show an improvement in literacy and numeracy scores in the evaluation test.
- At least 60% of students demonstrate increased learning motivation as measured through questionnaires.
- Increased student engagement and participation in PBL-based learning.

Although the success indicator of this study was set at a minimum of 70% of students demonstrating improvement in literacy and numeracy, the classroom action research was concluded at Cycle 3 based on practical and pedagogical considerations. The result of 68% indicates a substantial improvement compared to the initial condition and shows a consistent upward trend across cycles. At the end of Cycle 3, time constraints related to the academic calendar and curriculum schedule limited the possibility of conducting an additional cycle. Moreover, qualitative observations revealed notable improvements in students' problem-solving strategies, engagement, and learning motivation, suggesting that the PBL intervention had reached a level of

pedagogical effectiveness. Therefore, although the quantitative target was not fully achieved, the convergence of quantitative gains and qualitative evidence justified the completion of the research at Cycle 3.

III. Result and Discussion

A. First Cycle

In the first cycle, the implementation of the PBL model was introduced by presenting students with contextual problems that had to be solved in groups. In general, the research results in the classroom during the first cycle of learning showed that some students had low literacy and numeracy skills. This was indicated by their tendency to ask how to solve each question without clearly understanding its meaning.

Students were reluctant to attempt solving problems independently and constantly required guidance from the teacher. Additionally, they were not systematic in answering questions, as illustrated in the following figures.

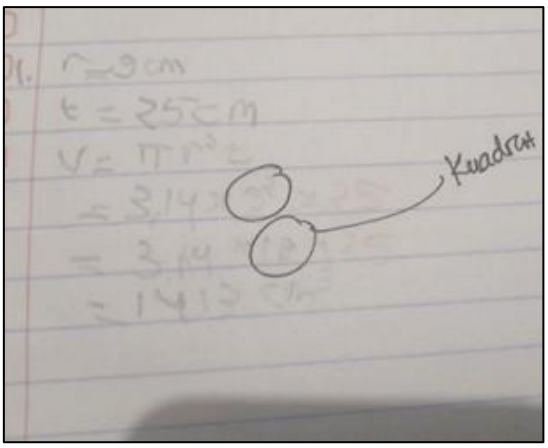

Figure 1. Students' mistake [1].

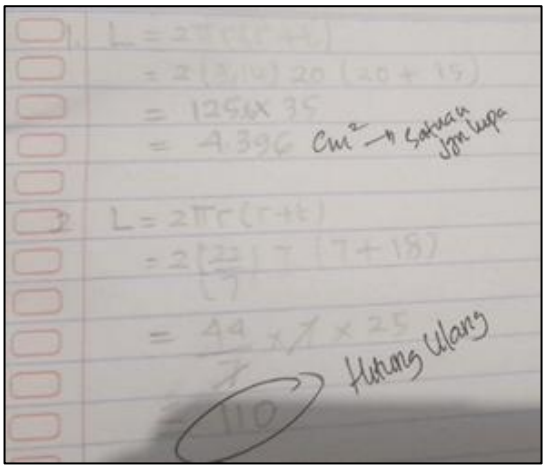

Figure 2. Students' mistake [2].

From Figures 1 and 2, it can be seen that students made mistakes in problem-solving, such as forgetting measurement units in the questions and making calculation errors. The recap of students' literacy and numeracy skills can be seen in Table 1.

Table 1.
Students' Literacy and Numeracy Skills

Category	Number of Students	Percentage of Students (%)
Excellent	-	0%
Good	4	16%
Fair	4	16%
Poor	10	40%
Very Poor	7	28%

Based on the table above, students' literacy and numeracy skills in the first cycle were still predominantly in the "poor" category. To follow up on this issue, the researcher conducted interviews with students, with the following results:

G: *What do you know about mathematics?*
S: *A difficult subject with strict teachers.*
G: *What makes learning mathematics difficult for you?*
S: *Understanding problems, especially word problems.*
G: *What makes you reluctant to study mathematics?*
S: *Because it involves calculations, and calculations are very difficult and confusing.*

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G: Which multiplication tables have you memorized?
S: Multiplication by 1, 2, 3, 5, and 10.

Based on these interview results, it became evident that students' learning motivation was still low, as shown by their lack of interest in participating in lessons and their minimal active engagement in learning activities. This resulted in poor learning outcomes, as students without intrinsic or extrinsic motivation tended to be passive, made little effort to understand the material, and struggled to complete academic tasks.

Students' learning outcomes are determined by the learning process itself. If learning motivation is low, students' literacy and numeracy skills will decline, leading to difficulties in understanding mathematical concepts, interpreting numerical information, and applying problem-solving in various contexts. Low learning motivation can hinder students' cognitive development, make it difficult for them to analyze math problems systematically, and negatively impact their academic performance (Murup et al., 2024). Therefore, innovative and interactive learning strategies are needed to enhance learning motivation, such as implementing the Problem Based Learning (PBL) model, which encourages active student participation in solving real-world problems.

B. Cycle Two

In this study, the intervention was conducted through several stages: planning, implementation, observation, and reflection.

In the planning stage, the lesson began with an introduction designed to spark students' curiosity and provide an overview of the material to be studied. During the main activity, students were divided into small groups of 2-3 people to discuss and collaborate in solving the given tasks. The lesson concluded with a reflection session, where students and the teacher reviewed the material and summarized their group discussions.

During the implementation stage, the Problem Based Learning (PBL) model was applied. In this method, students were given images and word problems, but with a step-by-step approach. The provided images contained layered information, where the final answer was not fully presented but instead given in the form of tables or blank columns that students needed to fill in. This approach aimed to help students gradually understand concepts and encourage them to think more critically in solving problems.

During the observation stage, the teacher not only acted as a facilitator, assisting students who faced difficulties, but also observed students' behavior during group work. The observation aimed to assess the extent of students' motivation to collaborate, understand the given concepts, and determine whether they showed interest in solving problems using the PBL model.

In the reflection stage, the learning outcomes from the second cycle showed an improvement in students' literacy skills. However, challenges remained in understanding image-based problems. Many students still struggled to connect

visual information with mathematical formulas, which limited their comprehension of graphical problems. Furthermore, students' numeracy skills had not shown a significant improvement, as they still found it difficult to understand basic arithmetic operations and apply fraction concepts in problem-solving.

Students' motivation also had not fully developed, although there was some improvement compared to the first cycle. Overall, the increase in students' literacy, numeracy, and learning motivation was only 15%, indicating that more effective learning strategies were still needed to help students gain a deeper understanding of the material and enhance their engagement in mathematics learning.

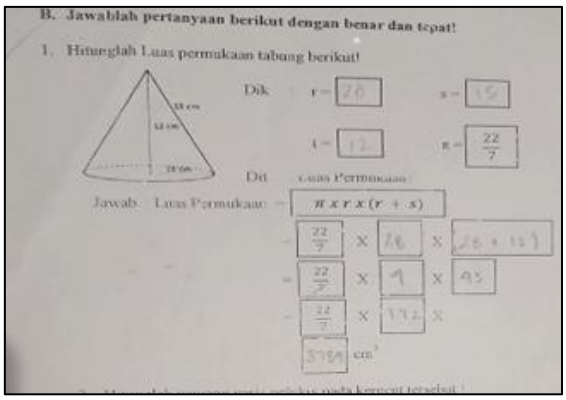

Figure 3. Students' answers [1].

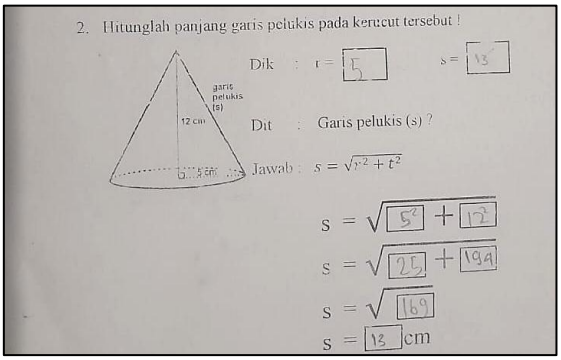

Figure 4. Students' answers [2].

Figures 3 and 4 show some of the students' answers in which blank columns were provided by the researcher, allowing students to simply fill in the answers. However, some students still struggled to understand the steps involved.

C. Cycle Three

In this study, the intervention was carried out through several stages: planning, implementation, observation, and reflection.

In the planning stage, the learning activities began with an introductory session aimed at building students' initial understanding of the concepts to be studied. During the core learning activity, students were divided into small groups of 2-3 members to collaborate in solving the given mathematical problems. The lesson concluded with a closing session, where the teacher allowed students to present conclusions from their group discussions and reflect on the learning process.

During the implementation stage, the Problem Based Learning (PBL) model was applied, where students were given images and word problems to analyze and solve independently. In the first cycle, students were given the freedom to write their problem-solving steps in a way that they understood systematically. However, in the second cycle, a slight modification was made by providing pre-structured answer columns, allowing students to fill in the blanks based on their analysis. This modification aimed to guide students toward structuring their answers more effectively and developing a better understanding of the concepts.

Throughout the observation stage, the teacher not only assisted students who faced difficulties but also observed their

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behavior and participation in group work. These observations were crucial to assessing students' learning motivation—whether they were more engaged in discussions, enthusiastic about completing tasks, or still struggling to grasp the material.

The reflection stage was conducted after completing the third cycle. The results showed a significant improvement in students' literacy, numeracy, and learning motivation. Compared to the second cycle, there was a 21% increase in students' literacy, numeracy, and motivation skills. Although the overall achievement percentage had not yet reached 70%, this improvement indicated that implementing the PBL model had a positive impact on students. Compared to the first and second cycles, the third cycle showed better progress in students' understanding of mathematical concepts and their active involvement in the learning process. This suggests that the applied strategy is beginning to yield positive effects, although further refinements are needed to optimize students' learning outcomes.

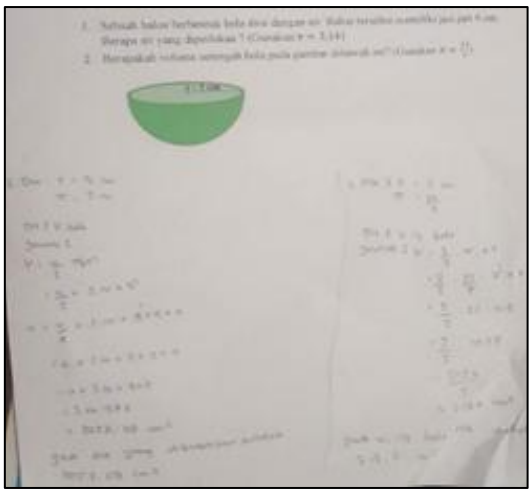

Figure 5. Learning Outcomes [1].

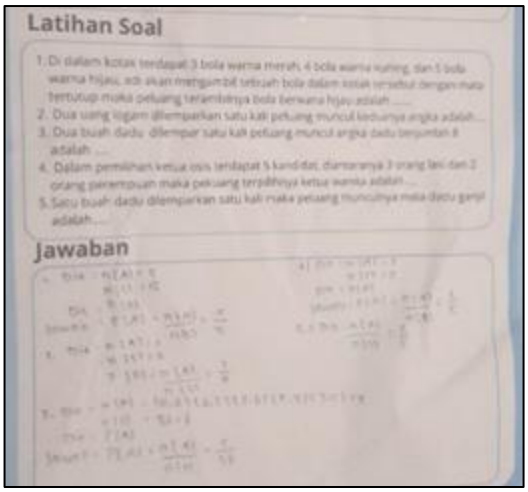

Figure 6. Learning Outcomes [2].

Based on the results from Cycle Two and Cycle Three, it can be concluded that literacy, numeracy, and student motivation increased by 36%, bringing the total percentage of students with improved literacy, numeracy, and motivation through the Problem-Based Learning (PBL) model to 68% of the total students, as shown in Table 2.

Although the predefined success indicator required at least 70% of students to demonstrate improvement in literacy and numeracy skills, the final result of 68% was considered meaningful within the context of this classroom action research. The difference of 2% indicates that the quantitative target was narrowly missed; however, this outcome must be interpreted alongside the qualitative findings. Observations across the cycles revealed clear improvements in students' confidence, active participation, and engagement during PBL-based learning activities. Students became more willing to express ideas, collaborate in groups, and attempt complex problem-solving tasks that they previously avoided. These

qualitative improvements suggest a positive shift in learning behavior and mathematical disposition, which is a critical indicator of instructional effectiveness in classroom-based interventions. Therefore, despite not fully meeting the numerical threshold, the convergence of quantitative gains and qualitative evidence supports the conclusion that the implementation of the PBL model was effective and justified the completion of the study at Cycle 3.

Table 2.
Student Literacy and Numeracy Skills

Category	Number of Students	Percentage of Students
Excellent	-	0%
Good	7	28%
Fair	10	40%
Poor	6	24%
Very Poor	2	8%

Positive Impact of Learning on Mathematical Problem-Solving Confidence

One of the positive impacts of learning is boosting students' confidence in solving mathematical problems. When students understand mathematical concepts well and can apply them correctly, they feel more assured in handling academic tasks. A study by Kusumaningrum (2017) found that students with high numerical literacy tend to have greater confidence in facing mathematics exams, ultimately contributing to an increase in their learning motivation.

Furthermore, numerical literacy helps students see the relevance between the material learned and real-life applications. When students realize that mathematics is not just a collection of formulas but has practical applications in their daily lives, they become more engaged in learning. The understanding that mathematical concepts can help in real-life situations, such as managing finances, calculating discounts, or interpreting statistical data, increases the relevance of learning and enhances students' interest in the subject.

Additionally, numerical literacy aids students in developing critical thinking and problem-solving skills. When students feel capable of solving mathematical problems independently, their confidence grows, encouraging them to be more active in the learning process. Students with strong literacy and numeracy skills are also more inclined to explore complex and challenging mathematical concepts.

In the Problem-Based Learning (PBL) model, students encounter various problems that require literacy and numeracy skills simultaneously. They must read, comprehend text, and analyze numerical data to find the correct solutions. Active engagement in problem-solving enhances their literacy and numeracy skills as they must interpret information, connect relevant concepts, and develop solutions based on their understanding of the presented data (Boangmanalu & Nasution, 2023).

For example, when solving real-life mathematical problems, students must read and understand the given information, process the numbers and data, and formulate an appropriate problem-solving strategy. Through the PBL approach, students learn to combine numerical understanding with critical thinking in both qualitative and quantitative analysis (Saputra & Lena, 2022). This method not only enhances their mathematical skills but also teaches them

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how to apply knowledge in real-world situations, making learning more meaningful and engaging.

The Problem-Based Learning (PBL) model also has a positive impact on students' motivation to learn mathematics. Hidayat & Suryani (2017) state that problem-based learning methods can increase student engagement in the learning process as they are encouraged to think critically and find solutions to real-world problems. This approach helps students feel more connected to the material, making them more motivated to seek answers and deepen their understanding.

In addition to enhancing literacy and numeracy, this learning model strengthens students' intrinsic motivation to continue learning (Riawati & Wahyuni, 2019). When students engage in problem-solving activities relevant to their lives, they feel more challenged and excited to learn (Sukarno & Setiawan, 2018). This sense of ownership over their learning process fosters greater independence in exploring various mathematical concepts. As a result, PBL creates a more engaging learning environment that stimulates students' curiosity, increasing their motivation to achieve a better understanding (Rabbani & Sumartini, 2023).

Beyond improving conceptual understanding, Problem-Based Learning (PBL) also helps develop critical thinking skills, which directly impact students' learning motivation. This model requires students to work independently or in groups, where they must explore different solutions, consider various perspectives, and communicate their ideas logically. Through group interactions, students exchange information, discuss concepts, and strengthen their understanding (Novianti & Kurniawati, 2020).

Through this process, students not only learn mathematics but also develop critical thinking and problem-solving skills that benefit them in real life (Hanipah & Sumartini, 2021). They become more confident in expressing their opinions and finding creative solutions to challenges. This boost in confidence directly impacts their intrinsic motivation, as they feel a greater sense of control over their learning journey. Thus, PBL not only improves academic competence but also fosters collaboration, communication, and reflective and analytical thinking skills.

IV. CONCLUSION

Overall, numeracy literacy plays a crucial role in enhancing students' learning motivation, especially in mathematics education. Strong numeracy literacy increases students' confidence, makes learning more relevant to real-life contexts, and supports the development of critical thinking skills. The Problem-Based Learning (PBL) model proves to be an effective approach for developing literacy and numeracy while simultaneously improving students' motivation to learn mathematics. By presenting real-world, problem-based challenges, students become more actively engaged in the learning process and are encouraged to think more deeply. In addition, PBL facilitates the development of problem-solving, collaboration, and reflective thinking skills, which contribute

to increased intrinsic motivation in mathematics learning. However, this study was conducted in a single class consisting of 25 students; therefore, the findings may not be directly generalizable to larger classes or different educational contexts.

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