

ENHANCING MATHEMATICAL LITERACY THROUGH PROBLEM-BASED LEARNING: A MIXED-METHODS ANALYSIS OF STUDENT PERFORMANCE

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Abstract

This study is a descriptive research using a qualitative and quantitative approach (mixed method) aimed at analyzing the mathematical literacy skills of students in Problem-Based Learning (PBL) instruction. The subjects of this study are students who participated in the research. The research instrument is the researcher themselves. Additionally, supporting instruments used in this study include: 1) a mathematical literacy skills test, 2) an observation sheet for the implementation of Problem-Based Learning, and 3) an observation sheet for student activity during learning. The data collected were analyzed using quantitative analysis, where the researcher calculated the mean and standard deviation from the motivation and interest in learning questionnaires. Further, qualitative analysis was conducted by the researcher through data reduction, presenting the data, and drawing conclusions. The results of the study indicate that students' mathematical literacy skills in PBL instruction are excellent.

Kata Kunci: Maksimum 5 kata, Dipisah dengan tanda koma, Spasi tunggal, Calibri (Brody), 12 pt.

A. Pendahuluan

According to PISA, literacy is a person's ability to formulate, apply, and interpret mathematics in various contexts. It includes the ability to reason mathematically and use concepts, procedures, and facts to describe, explain, or predict a phenomenon. This provides benefits for understanding the role of mathematics in life and using it effectively (Mardiyatri, et al., 2019).

The importance of mathematical literacy is not matched by the quality of education in Indonesia. The Organisation for Economic Cooperation and Development (OECD) defines mathematical literacy as the ability to identify and understand the role of mathematics in daily life and use it to make necessary mathematical decisions as a citizen who is engaged, caring, and thoughtful. Hidayati (2017) added that a person is considered to have good mathematical

literacy if they can analyze, reason, and communicate their mathematical knowledge and skills effectively, as well as solve and interpret mathematical solutions. Mathematical literacy in students is seen in how they use their mathematical abilities to solve problems that may arise in different contexts related to individual experiences.

This is evident from the PISA results released by the OECD (2018) in the mathematics category, where Indonesia scored an average of 379, ranking 73rd out of 79 participating countries. Additionally, a report from INSEAS, quoted by Tirta.id (2019), stated that in ASEAN, Singapore ranked first with a score of 77.27, followed by Malaysia (58.62), Brunei Darussalam (49.91), and the Philippines (40.94), while Indonesia ranked sixth with a score of 38.61. Observations made by the author at schools found that many students struggle when solving word problems that differ from the models presented by teachers. The data collected indicates that the quality of education in Indonesia is not optimal, and the level of mathematical literacy in the country is still low, far from expectations. However, there is alignment between literacy and the content standards of the subject. Students are expected to have this ability, in line with the importance of mathematical literacy.

One model that can be used to improve mathematical literacy is Problem-Based Learning (PBL), as stated by Mardiyatri, et al. (2019), that PBL is closely related to mathematical literacy. Problem-Based Learning is a teaching method that demands mental activity to understand a learning concept through contextual problems presented at the beginning of the lesson. The goal is to help students develop their problem-solving abilities related to everyday life. This model is student-centered, with the teacher playing the role of presenting problems and questions, setting the topics for discussion, and facilitating investigations and discussions. Teachers must also provide a supportive framework that enhances student inquiry and intellectual engagement (Kulimbang, 2018).

The active participants in Problem-Based Learning are the students, while the teacher serves as a facilitator. During the process, the teacher acts as a guide until the groups produce a final product from the problems they investigate (Azizah, 2022). Trianto (2010) adds that this learning process is conducted through small

group formation, where students work together to solve a problem that has been agreed upon by both the students and the teacher. The problems presented should be relevant to real-world events, as they help students think analytically, critically, and change their perception of the importance of mathematics in life. Sadia (2014) also stated that complex, contextual, and ill-structured problems provide opportunities for students to develop analytical, evaluative, and reflective thinking, fostering creativity in exploring information, developing potential solutions, and creating resources to solve problems. This is in line with the objective of Problem-Based Learning, as explained by Arends (2007), which is designed to help students develop thinking skills, problem-solving abilities, and intellectual skills through their experiences with real-world situations.

Wardono (2019) emphasized that the importance of mathematical literacy is not matched by the quality of education in Indonesia, as seen from various international assessments Indonesia participates in, including the Programme for International Student Assessment (PISA), which measures the literacy skills in reading, mathematics, and science of 15-year-old students or those at the junior high school level. The PISA results show that Indonesian students' mathematical literacy is still not optimal. Despite this, there is alignment between literacy and the content standards of mathematics, as the objective of the mathematics curriculum is to achieve mathematical literacy. Given the importance of literacy in mathematics learning, students are expected to possess these skills. Improving the quality of education can be achieved by selecting the appropriate and innovative teaching methods, one of which is Problem-Based Learning (PBL).

To address the issue of low mathematical literacy, it is essential to consider the broader context of education in Indonesia. Despite efforts to improve the quality of education, challenges such as limited access to quality teaching resources, inadequate teacher training, and unequal distribution of educational opportunities remain prevalent. These factors contribute to the gap in mathematical literacy, especially when compared to other countries. In this context, models like Problem-Based Learning (PBL) offer a promising approach by shifting the focus from traditional teacher-centered methods to student-centered, active learning. PBL engages students in solving real-world problems, fostering critical thinking,

collaboration, and a deeper understanding of mathematical concepts. As students work through contextual problems, they not only improve their problem-solving skills but also enhance their ability to apply mathematics in everyday life.

Furthermore, the integration of PBL into the classroom can be a catalyst for transforming the learning environment. It encourages students to take ownership of their learning, develop inquiry-based skills, and work collaboratively with peers to explore solutions. This aligns with the principles of constructivist learning theory, which emphasizes the importance of active learning experiences and social interaction in knowledge construction. Teachers, acting as facilitators, can guide students through the process, providing necessary scaffolding and encouraging reflective thinking. By incorporating real-world problems into the curriculum, PBL can make mathematics more relevant and engaging for students, helping them see the practical applications of what they learn and motivating them to pursue further mathematical studies.

B. Research Method

This research was conducted at a junior high school in Luwu Regency, South Sulawesi Province. The population in this study consists of all students in class VIII of the school.

The type of research used is descriptive research with a mixed-methods approach, combining quantitative and qualitative methods. The quantitative approach aims to assess students' mathematical literacy skills through Problem-Based Learning (PBL) and to determine the effectiveness of PBL in teaching. It also seeks to measure student responses. The qualitative approach aims to explore the process of developing mathematical literacy and the implementation of PBL, as well as to understand students' responses during the learning process. This includes their ability to reason mathematically and use concepts, procedures, and information to describe, explain, or predict a phenomenon.

C. Result and Discussion

The analysis of students' mathematical literacy skills was conducted based on their answers, aligned with the indicators for each question. The indicators that need to be met for each question are as follows:

1. **Formulating a situation in the form of a mathematical model using appropriate representations** – This measures students' ability to translate real-life situations into mathematical expressions or models.
2. **Using mathematical concepts, information, and procedures to solve everyday problems** – This evaluates how well students apply mathematical knowledge and processes in practical contexts.
3. **Interpreting and communicating the results or solutions to mathematical problems** – This indicator assesses how students can explain and present the solutions to the problems they have solved.
4. **Making arguments based on mathematical information or mathematical solutions** – This tests students' ability to justify their solutions with logical reasoning and mathematical support.

The data for assessing students' literacy skills were gathered from a mathematics literacy test conducted at the end of the lesson. Based on the research results from this test, students answered five questions that were designed to align with the respective indicators. The data collected reflects how well students met the expected literacy criteria for each question.

Tabel 1. Descriptive Statistics of Mathematics Literacy Test Results

Statistics	Frequency
Sample	33
Maximum	100
Minimum	44
Mean	84.06
Deviation Standar	14.57296
Variance	212.371
Range	56.00

Tabel 2. Categories of Students' Mathematics Literacy Test Skills

No.	Score	Category	Frequency
1	80 – 100	Very High	23
2	65 – 79	High	7
3	50 – 64	Moderate	2
4	35 – 49	Low	1
5	0 – 34	Very Low	0

Tabel 3 Mathematics Literacy Process of Students in the Class During Learning

Phase	Student Activity
Formulating Mathematical Situations	The students begin by reading the problem and identifying the mathematical aspects and variables within it. Next, they simplify the problem based on mathematical analysis and make estimations from the simplification performed. Afterward, they transform these estimations into a mathematical model and understand the relationship between symbolic and formal forms. The students then select the rules they consider most effective to connect the mathematical model to the problem's context and plan the steps they will take to solve the problem.
Applying Mathematical Concepts, Procedures, Facts, and Reasoning	Students perform basic calculations to evaluate whether their initial steps lead to an accurate solution. They utilize relevant mathematical formulas to aid in finding the correct solution. Subsequently, students leverage mathematical facts and structures to discover solutions, even manipulating numerical forms to extract necessary information. Following this, they make predictions based on the calculation results and explain and validate the mathematical findings they have achieved.
Interpreting, Applying, and Evaluating Mathematical Results	Students begin to communicate and interpret information derived from the solutions to mathematical problems. They reevaluate whether the results obtained align with the problem's context. If discrepancies are found, students revise their mathematical results to match the context. Subsequently, they explain why their results or conclusions do not fit the problem's context. They also engage in reasoning to make predictions, provide evidence-based arguments, and test and compare solutions proposed by their peers or alternative viewpoints from the class.

The descriptive statistical analysis of students' mathematical literacy test results revealed high levels of achievement among students taught using Problem-Based Learning (PBL) integrated with mathematical literacy activities. This approach demands mental engagement from students to understand concepts through contextual problems presented at the start of the learning process. PBL helps develop students' critical thinking skills to solve real-world problems while incorporating literacy activities that enable them to formulate, apply, and interpret mathematics in various contexts.

This aligns with Mardiyatri et al. (2019), who found a strong connection between PBL and mathematical literacy. Pamungkas et al. (2015) also reported an improvement in students' literacy skills through PBL. Additionally, Rasmiwetti et al. (2020) demonstrated that high-performing students excelled in all seven mathematical literacy indicators, such as mathematizing, reasoning, and effective use of mathematical tools.

Findings from Nolaputra et al. (2018) further substantiate that PBL, integrated with literacy-based approaches, yields better literacy outcomes compared to conventional methods. Students exposed to PBL with Realistic Mathematics

Education (RME) achieved greater literacy mastery and significant improvements across seven literacy components.

The study highlights the positive impact of PBL combined with literacy activities in achieving significant improvements in mathematical literacy, particularly on topics like the Pythagorean Theorem. This supports earlier research by Pratiwi and Ramdhani (2017), who concluded that PBL enhances mathematical literacy more effectively than traditional teaching methods. Similarly, Tabun et al. (2020) found that students in PBL settings exhibited higher literacy competencies than those in non-PBL classrooms.

These results underscore that well-designed learning processes, such as PBL paired with literacy integration, contribute significantly to students' understanding of mathematics. They also emphasize the importance of aligning learning strategies with lesson plans (RPP) to maximize the educational impact and encourage students to value and apply mathematical knowledge in real-life situations.

D. Conclusions

Students participating in learning through the Problem-Based Learning (PBL) model combined with mathematical literacy activities demonstrated excellent outcomes. The PBL method encourages active participation in solving real-world problems, while mathematical literacy activities equip them with skills to read, comprehend, and analyze mathematical information more effectively. The integration of these approaches enables students to develop critical and logical thinking abilities within the mathematical context. The high-achievement results reflect the effectiveness of this method in enhancing students' overall understanding and mathematical skills.

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