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Improving Math Learning Outcomes on Number Material through Problem Based Learning for 7th Grade Students

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Abstract
Mathematics learning outcomes among junior high school students remain a concern, particularly in understanding the concept of numbers and applying numerical operations in problem-solving situations. Students often experience difficulties in connecting mathematical concepts with contextual problems due to learning activities that are less focused on active exploration and problem-solving. Therefore, this study was conducted to address the need for an instructional approach that could improve students' understanding and achievement in mathematics learning, particularly on the topic of numbers.
This study aimed to describe the improvement of Grade VII students' mathematics learning outcomes through the implementation of the Problem-Based Learning model. The study employed a Classroom Action Research design involving 30 Grade VII students. Data were collected through learning outcome assessments consisting of quizzes and assignments after the learning activities. The collected data were analysed using descriptive statistical analysis to determine students' achievement and learning mastery.
The results showed that the implementation of the Problem-Based Learning model supported students' mathematics learning outcomes on the topic of numbers. Students achieved an average final score of 81.82, and 28 students (93.33%) reached the Minimum Mastery Criterion. Furthermore, students demonstrated consistent performance in understanding number concepts, performing numerical operations, and solving mathematical problems. These findings indicated that Problem-Based Learning provided meaningful learning experiences that encouraged students to actively participate, explore mathematical concepts, and develop problem-solving skills. This study implied that Problem-Based Learning could be applied as an alternative instructional strategy to improve mathematics learning outcomes at the junior high school level.

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1. Introduction (12 pt)

Mathematics is an essential subject in junior high school education because it contributes to the development of students' logical thinking, reasoning, and problem-solving abilities. Mathematical knowledge provides students with the ability to analyse situations, make decisions, and solve problems systematically. One of the fundamental topics in mathematics learning is Numbers, which includes integers, fractions, decimal numbers, and numerical operations. Understanding number concepts is important because it becomes a foundation for learning more advanced mathematical topics. However, many students still experience difficulties in

understanding number concepts and applying mathematical procedures in problem-solving situations.

Students' difficulties in learning Numbers are often associated with the tendency of mathematics instruction to emphasise memorisation and procedural skills rather than conceptual understanding. As a result, students may perform calculations correctly but have difficulty explaining mathematical concepts, selecting appropriate strategies, and applying their knowledge in contextual problems. According to NCTM (2000), effective mathematics learning should enable students to develop conceptual understanding, procedural fluency, problem-solving skills, and mathematical reasoning. Therefore, learning approaches that actively involve students in constructing knowledge are needed to improve mathematics learning outcomes.

One instructional approach that supports active mathematical learning is Problem-Based Learning (PBL). PBL is a student-centred learning approach that uses authentic problems as the starting point for investigation and knowledge construction. Savery (2006) stated that PBL encourages students to identify problems, search for relevant information, develop possible solutions, and reflect on the learning process. Through these activities, students are encouraged to become active learners who develop deeper understanding rather than simply receiving information from teachers.

Previous studies have demonstrated the effectiveness of PBL in improving students' mathematical abilities. Panjaitan and Suhendra (2022) reported that PBL positively contributed to students' mathematical competence, including conceptual understanding, mathematical communication, and problem-solving skills. Similarly, Siagian et al. (2023) found through meta-analysis that PBL had a significant effect on improving students' mathematical abilities. The implementation of PBL provides opportunities for students to engage in meaningful learning activities, collaborate with peers, and apply mathematical concepts to solve problems.

Although previous studies have shown positive effects of PBL in mathematics education, there is still a need for further research focusing on specific mathematical topics and classroom contexts. Many previous studies have examined general mathematical abilities, critical thinking skills, or problem-solving abilities, while fewer studies have specifically investigated students' learning outcomes on the topic of Numbers at the junior high school level. The topic of Numbers requires students to understand different types of numbers, perform numerical operations, and apply concepts in contextual problems. Therefore, investigating the application of PBL in teaching Numbers can provide additional evidence regarding its effectiveness in improving students' mathematics achievement.

Based on this research gap, this study aimed to describe the mathematics learning outcomes of Grade VII students on the topic of Numbers after the implementation of the Problem-Based Learning model. This study was conducted to provide empirical evidence regarding the use of PBL as an alternative instructional strategy to support students' understanding of mathematical concepts and improve learning outcomes in junior high school mathematics.

2. Literature Review

2.1 Problem-Based Learning in Mathematics Education

Problem-Based Learning (PBL) is a student-centred instructional approach that uses authentic problems as the foundation of the learning process. Unlike traditional teacher-centred instruction, PBL positions students as active participants who investigate problems, construct knowledge, and develop solutions through individual and collaborative activities. Savery (2006) explained that PBL is characterised by learning initiated from meaningful problems, where students are encouraged to identify what they know, determine what they need to learn, and apply knowledge to solve problems. This process enables students to develop not only cognitive abilities but also independent learning skills.

In mathematics education, PBL has been widely implemented because mathematical concepts often require reasoning, analysis, and problem-solving abilities. The use of contextual problems in PBL allows students to understand the relationship between mathematical concepts and real-life situations. According to Hmelo-Silver (2004), PBL facilitates deeper learning by

encouraging students to develop flexible knowledge, effective problem-solving skills, and self-directed learning strategies. Through discussion and investigation, students are provided with opportunities to compare different solution methods and construct mathematical understanding.

Previous studies have reported positive effects of Problem-Based Learning (PBL) on mathematics learning outcomes. Panjaitan and Suhendra (2022) found that PBL contributed to improving students' mathematical competence, including conceptual understanding, mathematical communication, and problem-solving abilities. Similarly, Siagian et al. (2023) reported that PBL had a significant positive effect on students' mathematical abilities based on a meta-analysis study. Recent studies have further confirmed that PBL supports mathematics achievement by encouraging students to actively construct knowledge, engage in collaborative discussions, and apply mathematical concepts in meaningful contexts (Fitriyah et al., 2022; Yohannes et al., 2021; Juandi et al., 2021).

Furthermore, research by Sari et al. (2022) indicated that PBL improved students' mathematical reasoning and critical thinking skills because students were encouraged to analyse problems and develop solution strategies. Pratiwi and Hidayat (2023) also found that the implementation of PBL enhanced students' mathematical problem-solving abilities through contextual learning activities. In addition, research conducted by Mulyono et al. (2024) demonstrated that PBL positively influenced students' conceptual understanding by providing opportunities for exploration, discussion, and reflection during mathematics learning. These findings suggest that PBL is not only effective in improving achievement outcomes but also contributes to the development of higher-order mathematical thinking skills.

However, the effectiveness of PBL may vary depending on learning contexts, students' characteristics, teacher facilitation, and the mathematical topics being taught. A study by Tamur et al. (2021) highlighted that variations in PBL implementation could influence the magnitude of its effect on students' mathematical abilities. Therefore, although previous studies have demonstrated the potential of PBL in mathematics education, further investigation is still needed to examine its implementation in specific topics, such as Numbers, among junior high school students. This study contributes by exploring how PBL supports students' learning outcomes in understanding number concepts and applying numerical operations in a classroom context.

2.2 Mathematics Learning Outcomes on the Topic of Numbers

Mathematics learning outcomes represent students' achievement after participating in learning activities, including their understanding, skills, and ability to apply mathematical concepts. In mathematics education, learning outcomes are not limited to obtaining correct answers but also include conceptual understanding, reasoning, and the ability to solve mathematical problems. The National Council of Teachers of Mathematics (2000) stated that effective mathematics learning should develop students' abilities in problem-solving, reasoning, communication, connections, and representation. These competencies are essential for students to develop meaningful mathematical knowledge.

The topic of Numbers is one of the fundamental areas in junior high school mathematics because it provides the foundation for understanding more complex mathematical concepts. Learning Numbers involves various concepts, including integers, fractions, decimal numbers, number comparison, and arithmetic operations. Students need to understand the relationships among different types of numbers and apply appropriate procedures when solving mathematical problems. However, research has shown that students frequently experience difficulties in learning number concepts, particularly when they are required to move from procedural calculations to conceptual reasoning and contextual problem-solving (Kilpatrick et al., 2001).

The application of appropriate instructional strategies is therefore important to improve students' learning outcomes in Numbers. PBL provides opportunities for students to explore numerical concepts through meaningful problems and collaborative discussions. By engaging students in problem-solving activities, PBL may support the development of conceptual understanding and mathematical reasoning. Research by Fitriyah et al. (2022) showed that PBL positively influenced students' mathematical reasoning abilities, which are closely related to

success in understanding number concepts. However, most previous studies have focused on general mathematical abilities rather than specifically examining learning outcomes on the topic of Numbers. This gap highlights the importance of investigating how PBL supports students' achievement in learning Numbers at the junior high school level.

Overall, the reviewed literature indicates that PBL has potential as an effective approach for improving mathematics learning outcomes. Nevertheless, further classroom-based research is needed to examine its application in specific mathematical topics and educational settings. This study contributes to the existing literature by investigating the implementation of PBL to improve Grade VII students' learning outcomes on the topic of Numbers.

3. Method

This study employed a Classroom Action Research (CAR) design to investigate the implementation of the Problem-Based Learning (PBL) model in improving Grade VII students' mathematics learning outcomes on the topic of Numbers. Classroom Action Research was selected because it is a systematic inquiry conducted by teachers or researchers to improve educational practices through cycles of planning, action, observation, and reflection (Kemmis et al., 2014). This research design enabled the researcher to identify learning problems, implement instructional improvements, and evaluate the effectiveness of the implemented learning strategy in the classroom setting.

The research was conducted at MTs Swasta Al-Hakimiyah Paringgonan during mathematics learning activities. The population of this study consisted of all Grade VII students at the school. The research participants were 30 students from one Grade VII class who were selected using purposive sampling. The selection of participants was based on the identification of students' difficulties in understanding the topic of Numbers, including integers, fractions, decimal numbers, and numerical operations. According to Creswell and Creswell (2023), purposive sampling is appropriate when researchers select participants who can provide relevant information related to the research obectives.

The research procedure followed the CAR cycle consisting of four main stages: planning, acting, observing, and reflecting (Kemmis et al., 2014). In the planning stage, the researcher prepared lesson plans based on the Problem-Based Learning model, learning materials, student worksheets, and assessment instruments. In the action stage, the researcher implemented PBL activities in which students were presented with contextual problems related to Numbers. Students were guided to analyse problems, identify relevant mathematical concepts, discuss possible solutions, present their findings, and evaluate the problem-solving process. The observation stage was conducted during the learning activities to record students' participation and learning progress, while the reflection stage was used to evaluate the results of the implemented action and determine possible improvements for subsequent learning activities.

The research instruments consisted of mathematics learning outcome assessments, including quizzes and assignments. The instruments were developed based on the learning objectives and indicators of the Numbers topic, including identifying types of numbers, performing arithmetic operations, comparing numerical values, and solving contextual mathematical problems. The validity of the instruments was ensured through alignment between assessment items and learning objectives, while reliability was maintained through consistent implementation and scoring procedures. According to Sugiyono (2022), research instruments in educational studies should meet validity and reliability requirements to ensure that the collected data accurately represent the investigated variables.

Data were collected after the implementation of learning activities through students' quiz and assignment scores. The collected data were analysed using descriptive statistical analysis by calculating the minimum score, maximum score, mean score, and percentage of students achieving the Minimum Mastery Criterion. Descriptive analysis was used because the purpose of the study was to describe students' learning outcomes after the implementation of the Problem-Based Learning model. As stated by Creswell and Creswell (2023), descriptive analysis is useful for summarising and presenting patterns found in quantitative data.

Several assumptions were considered during the implementation of this study. It was assumed that students participated actively in the learning process and completed the assessment tasks honestly according to their abilities. The researcher also assumed that the learning environment and instructional time provided sufficient opportunities for students to engage in Problem-Based Learning activities. However, this study had limitations because it involved only one class at MTs Swasta Al-Hakimiyah Paringgonan and focused on one mathematics topic, namely Numbers. Therefore, the findings should be interpreted within the specific classroom context in which the research was conducted.

4. Results

This study aimed to describe the mathematics learning outcomes of Grade VII students on the topic of Numbers after the implementation of the Problem-Based Learning (PBL) model. Students' learning outcomes were measured using quiz and assignment scores administered at the end of the instructional activities. The data were obtained from 30 students and were analyzed using descriptive statistics.

4.1 Students' Learning Outcomes on the Topic of Numbers

The descriptive statistics of students' learning outcomes on the topic of Numbers are presented in Table 1.

Table 1. Descriptive Statistics of Students' Learning Outcomes on the Topic of Numbers

Assessment	N	Minimum	Maximum	Mean
Quiz	30	79	85	81.40
Assignment	30	79	86	82.23
Final Score	30	79.00	85.50	81.82

Table 1 shows that students obtained satisfactory learning outcomes in both assessments. The mean assignment score (82.23) was slightly higher than the mean quiz score (81.40), indicating that students demonstrated better performance when completing the assignments than during the quiz. The final average score was 81.82, with scores ranging from 79.00 to 85.50.

The score distribution also showed relatively small differences among students. Most students achieved scores between 80 and 83, while only a few students obtained the minimum score of 79 or the maximum scores of 85 and 86. This distribution indicates that students' achievement was relatively consistent across the class.

Students' learning mastery based on the Minimum Mastery Criterion (MMC) of 80 is presented in Table 2.

Table 2. Students' Learning Mastery on the Topic of Numbers

Category	Number of Students	Percentage (%)
Achieved Mastery (≥80)	28	93.33
Did Not Achieve Mastery (<80)	2	6.67
Total	30	100.00

As shown in Table 2, 28 out of 30 students (93.33%) achieved the minimum mastery criterion, whereas only two students (6.67%) did not reach the expected level of achievement. These results indicate that nearly all students successfully completed the learning activities on the topic of Numbers.

A comparison of quiz and assignment scores revealed that most students obtained assignment scores that were equal to or higher than their quiz scores. Several students improved their performance by two to six points in the assignment, whereas only a small number of students obtained lower assignment scores than quiz scores. Overall, the learning outcome data demonstrated a stable pattern of achievement across both assessment components.

The findings also indicated that students' scores were concentrated within a narrow range, suggesting a relatively homogeneous level of academic performance. No extreme score differences were observed among students, and the majority consistently achieved scores above the minimum mastery criterion. This pattern showed that the learning outcomes of the class were generally consistent following the implementation of the learning activities on the topic of Numbers.

5. Discussion

The findings of this study showed that the implementation of the Problem-Based Learning (PBL) model improved students' mathematics learning outcomes on the topic of Numbers. The results indicated that most Grade VII students achieved the Minimum Mastery Criterion, and the overall learning outcomes showed consistent achievement across the class. These findings suggest that PBL provided an effective learning environment for students to understand mathematical concepts and complete learning tasks related to numbers.

The achievement of students in this study can be explained by the characteristics of Problem-Based Learning, which emphasizes active involvement in solving authentic problems. According to Savery (2006), PBL is a learner-centered instructional approach in which students actively investigate problems, identify information needed to solve problems, and construct knowledge through the learning process. This approach allows students to become active participants rather than passive recipients of information. Therefore, the learning process in PBL can support students in developing deeper conceptual understanding.

The results showed that students performed slightly better in assignments than in quizzes. This condition may occur because PBL provides students with opportunities to discuss, analyze, and evaluate problem-solving strategies during learning activities. Through collaborative activities, students can exchange ideas and receive feedback from peers and teachers. Panjaitan and Suhendra (2022) stated that PBL contributes to improving students' mathematical competence, including conceptual understanding, problem-solving ability, and mathematical communication skills. These competencies are important in learning Numbers because students need to understand relationships among different types of numbers and apply mathematical operations appropriately.

Furthermore, the high percentage of students achieving mastery in this study supports previous findings that PBL has a positive effect on mathematics learning outcomes. A systematic review conducted by Siswanto, Rahayu, and Meiliasari (2024) reported that PBL encourages students to develop critical thinking, analytical skills, and mathematical problem-solving abilities through active participation in learning activities. In the context of this study, students were involved in activities requiring them to identify number concepts, perform calculations, and solve contextual mathematical problems. These activities provided opportunities for students to apply mathematical knowledge rather than only memorize procedures.

The findings are also consistent with a meta-analysis conducted by Siagian, Darhim, and Juandi (2023), which reported that PBL positively influences students' mathematical abilities, including reasoning, communication, representation, and problem-solving skills. The positive learning outcomes obtained in this study indicate that the stages of PBL, including presenting problems, investigating solutions, discussing findings, and evaluating solutions, supported students' mathematical learning processes.

In learning the topic of Numbers, students were required to understand several concepts, such as integers, fractions, decimal numbers, and arithmetic operations. These concepts often require students to develop logical reasoning because they involve comparing values, selecting appropriate procedures, and applying calculations in different contexts. Through problem-oriented activities, students were encouraged to connect mathematical concepts with real-life situations. This finding is supported by research showing that contextualized PBL can improve students' engagement and conceptual understanding because students learn mathematics through meaningful situations.

Although the overall results showed positive achievement, a small number of students had not reached the Minimum Mastery Criterion. This indicates that individual differences in prior knowledge, learning speed, and mathematical ability may influence students' achievement. Therefore, teachers need to provide additional guidance and differentiated learning support for students who experience difficulties, especially when dealing with numerical operations and problem-solving activities.

Overall, the findings of this study demonstrate that the Problem-Based Learning model supported students' mathematics learning outcomes on the topic of Numbers. The active learning process, collaborative discussion, and problem-solving activities provided students with opportunities to develop conceptual understanding and mathematical reasoning. These results reinforce previous studies indicating that PBL is an appropriate instructional model for mathematics learning, particularly for topics that require students to analyze and apply mathematical concepts.

6. Conclusion

This study concluded that the implementation of the Problem-Based Learning (PBL) model contributed positively to Grade VII students' mathematics learning outcomes on the topic of Numbers. The learning activities using the PBL approach supported students in understanding numerical concepts, including number classification, arithmetic operations, and solving problems related to numbers.

The results showed that students achieved satisfactory learning outcomes after participating in the learning activities. Most students reached the Minimum Mastery Criterion, and the learning achievement demonstrated a relatively consistent pattern across the class. The improvement in students' performance was reflected through their ability to complete quizzes and assignments related to the topic of Numbers.

The findings indicate that Problem-Based Learning can be considered an appropriate instructional model for mathematics learning, particularly for topics that require conceptual understanding and problem-solving skills. Through problem exploration, discussion, and solution evaluation, students were provided with opportunities to actively construct mathematical knowledge.

Therefore, the application of the Problem-Based Learning model is recommended as an alternative learning strategy to support students' mathematics achievement. Further studies may explore the implementation of PBL in other mathematical topics and different educational contexts to obtain broader findings.

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