

Analysis of Third Grade Elementary School Students' Numeracy Literacy Skills in Solving Contextual Problems with the Help of The PBL Model

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Abstract. Initial observations indicate that elementary school students' numeracy literacy is still low, especially in connecting mathematical concepts to real-world contexts, so that the learning process has not been able to optimally develop numeracy skills. Based on these issues, this study aims to analyze students' numeracy literacy abilities in solving contextual problems with the help of the Problem-Based Learning (PBL) model. This study uses a quantitative approach with a pre-experimental design of one group pre-test and post-test. The results show a significant increase in numeracy literacy scores after the implementation of the PBL model, with a pretest average score of 60.03 (SD = 9.642) and a posttest average score of 78.14 (SD = 7.678), as well as an average difference of 18.114. A correlation value of 0.813 ($p < 0.001$) and a t-value of -19.089 ($p < 0.001$) indicate a strong positive effect, with a very large effect size (Cohen's $d = -3.227$). These findings prove that problem-based learning is effective in improving numeracy literacy by strengthening elementary school students' critical thinking and contextual problem-solving skills.

Keywords: Numeracy literacy, logical thinking skills, learning strategies, education.

INTRODUCTION

Education plays a central role in shaping human resources who are able to adapt and compete amid the rapid pace of globalization, digitalization, and technological developments. In the 21st century, students are expected not only to master basic knowledge, but also to possess important skills such as critical thinking, problem solving, effective communication, and collaboration in various contexts. The 21st Century Skills framework (P21, 2019) places these competencies as the main provisions for facing social dynamics and the demands of the modern world of work.

In relation to these competencies, numeracy literacy emerges as a very important basic skill. Numeracy literacy is not limited to the ability to perform arithmetic operations, but includes the ability to understand, interpret, and use number-based information in various life situations. The OECD (2019) emphasizes that this skill helps individuals make more informed decisions, especially in a digital environment that is saturated with quantitative information.

Recent research increasingly shows that numeracy literacy contributes significantly to the development of student competencies. (Garcia-retamero et al., 2019), for example, shows that

numeracy literacy is closely related to data literacy and complex problem-solving skills, which are essential in an information-based society. The UNESCO (2020) also emphasizes that numeracy literacy is an essential life skill for supporting individuals' productive participation in social and economic life. Thus, numeracy literacy is not only important in school learning but also a basic skill that helps students understand the modern world, which is increasingly dominated by data and quantitative information.

In Indonesia, attention to the importance of numeracy literacy is also growing. Through the National Literacy Movement (GLN), the government has positioned numeracy literacy as one of the six fundamental literacies that need to be developed in students (GLN Team, 2017). This emphasis is in line with the previous discussion on the urgency of numeracy literacy in facing the demands of the 21st century. In the context of national education, numeracy literacy is understood not only as the ability to calculate, but also as the ability to understand, interpret, and use various mathematical representations in diverse situations. This ability also includes reasoning skills, pattern recognition, risk analysis, and decision making based on quantitative information.

This understanding reinforces the view that numeracy literacy is multidimensional and contributes directly to the intellectual, social, and economic development of students. This is in line with the OECD (2019) report, which emphasizes that numeracy literacy is the main foundation for building critical thinking and problem-solving skills, especially in an era where daily life is increasingly influenced by data, technology, and numerical information. Thus, Indonesia's efforts to strengthen numeracy literacy are not only part of education policy but also a strategic step to ensure students are prepared to face the ever-evolving dynamics of modern life.

In the context of basic education, especially at the third-grade level, strengthening numeracy literacy plays an increasingly important role. At this stage, students are in a phase of cognitive development that is moving from concrete thinking to more complex operational abilities. This development requires a learning approach that not only emphasizes memorization of procedures but also builds a deeper conceptual understanding. Rittle-Johnson and Schneider (2015) explain that conceptual and procedural understanding are interrelated and develop reciprocally, so meaningful and contextual learning experiences are needed to ensure optimal numeracy development.

In everyday learning, teachers play an important role in providing learning experiences that are relevant to real life, so that students can see how numeracy concepts are used in situations

they encounter. This approach not only helps strengthen students' understanding of mathematical concepts, but also builds their confidence in using quantitative information. With a strong foundation in numeracy literacy from an early age, students will be better prepared to face the challenges of learning at the next level and the demands of the 21st century, which increasingly emphasize analytical skills, problem solving, and data-based decision making.

However, various studies show that the numeracy literacy of elementary school students in Indonesia is still relatively low. This low level of ability is reflected in students' difficulty in understanding quantitative information, choosing appropriate problem-solving strategies, and connecting mathematical concepts to real-life contexts. This condition is reinforced by the findings of the Programme for International Student Assessment (PISA), which shows that Indonesian students' mathematical literacy achievements are still below the OECD average, particularly in the indicators of contextual problem solving, mathematical reasoning, and data interpretation (OECD, 2019). Similar results were shown by the Trends in International Mathematics and Science Study (TIMSS), which revealed that Indonesian students still have difficulty solving problems that require application skills, the use of visual representations, and higher-level thinking in mathematics (Utomo, 2021).

A systematic literature review conducted by (Setiawan et al., 2024) shows that the development of numeracy literacy in elementary schools still faces various challenges. These obstacles are not only related to students' cognitive abilities but are also influenced by factors outside of the students themselves, such as limitations in teachers' pedagogical competence, low student confidence in solving mathematical problems, a lack of teaching materials relevant to real life, and a lack of learning support facilities. These findings confirm that numeracy literacy will not develop optimally if the learning environment does not provide opportunities for students to interact with authentic problems and gain meaningful learning experiences.

Based on these conditions, a learning approach is needed that can address existing challenges while providing space for students to build mathematical understanding more actively and contextually. Learning models that involve students in exploration, discussion, and real-world problem solving are beginning to be seen as promising alternatives. Such approaches not only help students understand numeracy concepts more deeply, but also enable them to develop critical thinking and analytical skills that are essential for 21st-century learning. Thus, choosing the right learning strategy is an important step in overcoming the identified obstacles and promoting numeracy literacy from an early age.

In addition, various field studies also show that elementary school students still face difficulties when dealing with contextual problems that require interpretation, analysis, and mathematical modeling skills. (Husna et al., 2025) found that most students tend to be more comfortable solving routine procedural problems. Conversely, they experience obstacles when asked to work on word problems, read tables and graphs, or process numerical data that requires higher-level reasoning. This condition shows that the mathematics learning they receive does not fully support the comprehensive development of numeracy skills.

These difficulties are further exacerbated by teaching practices that are still teacher-centered, with an emphasis on providing formulas and procedural steps. This pattern often deprives students of the opportunity to explore their own ways of thinking, build conceptual understanding, and relate mathematical knowledge to real-life experiences. As a result, their ability to interpret and use quantitative information becomes limited. These empirical findings further emphasize the importance of implementing more innovative and contextual learning approaches, approaches that are able to present real problems, encourage students to think critically, and provide space for them to build their own understanding of numeracy. This is a strategic step in improving the quality of numeracy literacy among elementary school students.

Contextual problems play a key role in modern mathematics learning because they enable students to integrate numeracy skills with higher-order thinking skills. However, many students still experience difficulties in interpreting information, modeling problems mathematically, and determining the appropriate solution strategies (NCTM, 2020). These obstacles are often influenced by weak conceptual understanding, minimal problem-based learning experiences, and a lack of opportunities to practice critical thinking systematically.

One pedagogical approach that is increasingly recognized as capable of overcoming various numeracy literacy challenges in elementary schools is Problem-Based Learning (PBL). Recent research shows that PBL can improve various aspects of mathematical and numeracy skills through authentic problem-solving activities. (Yong Liu a, 2022) found that PBL significantly improved elementary school students' problem-solving skills, mathematical reasoning, and learning motivation. This is because PBL provides opportunities for students to explore ideas, discuss, and find solutions independently or collaboratively.

Additionally, research by (Rintayati, 2023) explains that PBL helps students build stronger conceptual understanding through inquiry processes and meaningful learning experiences. When students are directly involved in identifying problems, gathering information, and

interpreting data, they not only develop critical thinking skills but also metacognitive skills that are important for long-term learning.

In the context of numeracy literacy, PBL has proven to be effective because it presents real-life situations that allow students to apply mathematical concepts functionally. A study by (Maryati & Monica, 2021) confirms that PBL contributes positively to students' ability to understand mathematical representations, read numerical data, and solve contextual problems. Thus, PBL not only makes mathematics learning more relevant and applicable, but also strengthens numeracy literacy through meaningful and contextual learning experiences.

Based on this background, this study aims to analyze the numeracy literacy abilities of third-grade students in solving contextual problems through the application of the Problem-Based Learning (PBL) model. This study is expected to provide empirical contributions regarding the effectiveness of PBL as a pedagogical approach that can strengthen numeracy literacy in primary education. By presenting problems that are close to everyday experiences, PBL enables students to understand numeracy concepts more naturally while developing critical and analytical thinking skills.

In addition, this study also seeks to describe the extent to which the application of PBL can improve students' ability to interpret quantitative information, solve authentic problems, and use mathematical representations more functionally. Thus, this study not only provides an overview of students' numeracy literacy achievements but also assesses the relevance of PBL as a learning model that can be effectively implemented in the context of elementary schools.

METHODOLOGY

This study used a quantitative method with a one-group pretest–posttest pre-experimental design. This design allowed researchers to directly observe changes in students' numeracy literacy skills before and after treatment, so that the effectiveness of the PBL model could be evaluated in greater depth. The choice of a pre-experimental design is also appropriate for learning conditions in elementary schools, where researchers do not always have full control over class grouping or the formation of control groups.

The quantitative approach is considered relevant because it can produce objective, measurable data that can be analyzed statistically. According to Creswell (2018), quantitative research is used when researchers want to test assumptions or relationships between variables through systematic and structured procedures. In line with this, (Ary et al., 2019)

states that quantitative methods are appropriate when the research objective is to empirically measure the effect of an intervention. Meanwhile, (Fraenkel et al., 2020) emphasize that the pretest–posttest design is one of the most effective approaches in assessing the improvement in students' abilities after a certain treatment.

Referring to these various views, the use of quantitative methods and a one-group pretest–posttest design in this study can be considered appropriate and relevant. The combination of the two provides a strong scientific basis for evaluating the impact of PBL on students' numeracy literacy objectively, measurably, and accountably. The subjects of this study consisted of 35 third-grade students from an elementary school in Bandung. The subjects were selected using purposive sampling, a sampling technique based on specific considerations to ensure that the sample characteristics were in line with the research objectives. In this context, the selected class had implemented integrated thematic learning and had uniform cognitive development characteristics, making it relevant for assessing the effectiveness of the PBL model on numeracy literacy.

The use of purposive sampling is supported by a number of expert views. Sugiyono (2019) explains that this technique is used when researchers need samples that are considered to best understand the context or issues being studied. Furthermore, Creswell & Creswell (2018) emphasize that purposeful selection allows researchers to choose individuals who can provide the most accurate and meaningful data to answer research questions. In line with this, Neuman (2014) states that purposive sample selection is important when research focuses on depth of information rather than statistical representation.

Referring to these views, the use of purposive sampling in this study can be considered appropriate because it allows researchers to obtain subjects that are truly relevant to the focus of the study, so that the data obtained is richer, more accurate, and supports the objective of evaluating the effectiveness of PBL in improving students' numeracy literacy. The data collection instrument in this study was a numeracy literacy test consisting of 10 contextual essay questions. The questions are based on everyday contexts, reflecting the view that numeracy literacy is not merely the ability to perform calculations, but also involves the ability to understand and use mathematical concepts in real-life situations. This is in line with the OECD (2019) framework, which emphasizes that numeracy literacy should be evaluated through contextual tasks that require interpretation, reasoning, and data-based decision-making.

The instruments were developed with reference to the numeracy literacy indicators from the Ministry of Education and Culture and the learning materials in the third-grade thematic books to suit the cognitive development of students. This approach is relevant to the findings by Wijaya (2017), which also show that contextual mathematics questions can improve students' ability to understand mathematical representations while training their reasoning in solving more complex problems. Thus, the use of contextual essay questions is considered appropriate for comprehensively measuring numeracy literacy, as it not only assesses students' procedural abilities but also their ability to interpret information, analyze situations, and apply mathematical concepts in various real-life contexts.

Before being used in research, this test instrument has undergone content validity and reliability testing to ensure its quality. Content validity is conducted to ensure that each item truly represents the numeracy literacy construct to be measured and is relevant to the research objectives. Creswell (2018) emphasizes that content validity is an important step in ensuring the suitability of the indicators to be measured with the material presented in the instrument. The validation process was carried out through expert judgment, as recommended by Sugiyono (2019), namely by requesting assessments from experts in the field of mathematics education on the material, construction, and clarity of language in each item.

In addition to content validity, the instrument also undergoes reliability testing through limited trials on small groups of students with characteristics similar to the research subjects. This step aims to see the level of consistency and stability of the instrument when used in relatively similar conditions. This view is in line with (Fraenkel et al., 2020), who state that the reliability of an instrument can be assessed from the consistency of the results obtained in repeated measurements. Similar findings are also reinforced by recent studies, such as those cited by Taherdoost (2016), which state that instrument testing is an important procedure for identifying items that are ambiguous, unrepresentative, or inconsistent.

By going through this validity and reliability process, the research instrument can be ensured to have adequate quality to measure students' numeracy literacy skills accurately, consistently, and scientifically accountable. Data collection was conducted through pretest and posttest to see the extent to which students' numeracy literacy skills improved after they participated in learning with the Problem-Based Learning (PBL) model. This approach is in line with Creswell's (2018) explanation that the pretest-posttest design helps researchers understand the changes that occur before and after an intervention is given.

The research data were analyzed using descriptive and inferential statistics through SPSS software version 29. Descriptive analysis served as the first step to provide an overview of students' numeracy literacy skills. By displaying the average values, score variations, and development patterns, researchers can understand the characteristics of the data thoroughly before conducting further testing. This approach is in line with Sugiyono's (2019) view that understanding the initial data is very important to ensure the validity of the research results and minimize misinterpretation. Descriptive analysis also helps identify the initial conditions of the data, such as the presence of outliers, abnormal distributions, or differences in variance between groups. This understanding is important because statistical assumptions, such as normality and homogeneity of variance, must be met for inferential tests to produce valid results (Field, A. 2018).

After understanding the characteristics of the data, this study used a paired sample t-test to examine the effectiveness of the Problem-Based Learning (PBL) model. This test compares the pretest and posttest scores of the same students, so that individual changes as a result of the PBL intervention can be observed. This approach is very appropriate because the paired t-test allows researchers to assess whether the changes in scores are statistically significant or merely coincidental. Recent literature supports the use of paired t-tests in the context of educational research, particularly for pretest–posttest designs. For example, research on the application of PBL in mathematics learning shows that the use of paired t-tests is effective in proving an increase in students' numeracy skills after intervention Irje (2021). Thus, this test not only tests hypotheses but also provides empirical evidence that PBL has a positive impact on students' numeracy literacy.

Overall, the combination of descriptive and inferential analysis in this study ensures measurable, transparent, and accountable findings. Descriptive analysis provides a clear initial overview, while the paired sample t-test reinforces the claim of PBL's effectiveness with valid statistical evidence. This approach ensures that the research results are not only practically relevant but also scientifically sound. This study also calculated the effect size to determine the extent of PBL's influence on improving students' numeracy literacy. According to Cohen (1988), effect size provides a more meaningful understanding because it shows the strength of the intervention's influence, not just whether the differences are statistically significant.

RESULTS AND DISCUSSION

The results of this study were obtained from numeracy literacy tests administered to students in integrated thematic learning at elementary schools. These tests were designed to assess how students understand, process, and use number-based information in situations close to their daily lives. The data obtained was then processed using SPSS version 29, so that the analysis was more structured, accurate, and easy to interpret. Through this process, researchers were able to describe the development of students' numeracy literacy skills more clearly and comprehensively.

Description of Pretest and Posttest Data

This section presents an overview of students' numeracy literacy skills before and after the implementation of the Problem-Based Learning model. The analysis was conducted using descriptive and inferential statistics in accordance with the paired sample design.

Table 1. Descriptive Analysis Results

Treatment	N	Minimum	Maximum	Mean	Standar Deviation
<i>Pretest</i>	35	40	75	60.03	9.642
<i>Posttest</i>	35	60	90	78.14	7.678
Valid N (listwise)	35				

Based on the results of descriptive statistical analysis in Table 1, it is clear that students' numeracy literacy skills improved after the implementation of the Problem-Based Learning (PBL) model. Before the learning began, the average pretest score was 60.03 with a minimum score of 40 and a maximum score of 75, and a standard deviation of 9.642. After students participated in problem-based learning, the average posttest score increased to 78.14, with a minimum score of 60, a maximum score of 90, and a standard deviation of 7.678. This change indicates a significant improvement in students' numeracy skills.

This improvement can be explained by the way PBL works, which encourages students to think more actively. In this learning method, students are invited to solve problems that are relevant to their lives, making the learning process more meaningful. This is in line with constructivist theory, especially Vygotsky's idea, which emphasizes that students' understanding will develop when they are involved in activities that require collaboration and deep thinking. Similarly, Bruner explains that students will learn better when they discover and construct the concepts they are learning themselves. From the context of numeracy literacy,

this increase in scores can also be understood as the result of activities that train students' information processing skills. Through PBL, they do not simply work on problems, but learn to interpret data, analyze situations, and make decisions based on numerical information. It is this mental process that helps them understand concepts more deeply, so that the learning outcomes are reflected in higher post-test scores.

This improvement shows that the PBL model has a positive impact on the numeracy literacy skills of third-grade students. The average difference between the pre-test and post-test of 18.11 indicates an increase in students' understanding of solving contextual problems. The decrease in standard deviation on the post-test also shows that the distribution of scores became more even after the intervention, which can be interpreted as an increase in more consistent understanding among students. These results are in line with previous studies that state that problem-based approaches can improve critical thinking skills and a deeper understanding of mathematical concepts (Pt et al., 2020). Therefore, the PBL model can be recommended as an effective learning strategy to improve numeracy at the elementary school level.

Paired Sample Correlation Test Results

The paired sample correlation test showed a value of $r = .813$ ($p < .001$), indicating a strong and significant relationship between pretest and posttest scores. This high correlation shows that the development of students' numeracy skills after the intervention was consistent. In the context of educational research, such a strong correlation indicates that the changes in posttest scores are not random but are closely related to the improvement in abilities built up during the learning process.

According to (Fraenkel et al., 2015), a high correlation between two paired measurements indicates that the treatment given has a real contribution to the subjects' performance, especially when both measurements are conducted on the same group. Additionally, Creswell (2018) explains that a strong relationship in a pretest–posttest design can be an indicator that the intervention has a targeted effect, as students show a relatively stable pattern of improvement.

From a learning theory perspective, these findings are in line with constructivist views, especially Vygotsky's idea of the zone of proximal development (ZPD), which states that students' abilities develop gradually through structured learning experiences supported by challenging activities. Because PBL provides tiered problem-solving tasks that are relevant to

real life, students tend to build knowledge gradually and consistently, resulting in a strong relationship between pretest and posttest scores. Thus, this high correlation value not only confirms the relationship between the scores but also strengthens the argument that PBL contributes significantly to the development of students' numeracy literacy skills.

Paired Sample t-Test Results

Analysis of score differences using a paired sample t-test showed a very significant increase from the pretest to the posttest ($t(34) = -19.089, p < .001$). These findings indicate that learning using the Problem-Based Learning (PBL) model has indeed brought about changes in students' numeracy literacy skills. In other words, the increase that occurred was not coincidental, but was a real effect of the intervention provided. This is reinforced by Field's (2018) opinion that the paired sample t-test is indeed used to see if there are truly meaningful changes in the same group before and after receiving a certain treatment. When the t-value produced is very large and significant, as in this study, it indicates that the treatment, in this case PBL, can have a strong influence on students' abilities.

From a learning theory perspective, these results are in line with Bruner's (1961) idea that students will understand concepts better when they are actively involved in the process of discovering and solving problems. In addition, Hmelo-Silver (2004) explains that PBL helps students develop higher-order thinking skills, such as reasoning, analysis, and problem solving, all of which are closely related to numeracy literacy.

Thus, this significant increase in scores can be seen as evidence that PBL creates a more meaningful learning experience, engages students more, and helps them understand numeracy concepts more deeply.

Effect Size

The effect size calculation in this study resulted in a Cohen's d value of -3.23 , which indicates a very large effect. This figure illustrates that the application of PBL has indeed brought about a strong and noticeable change in students' numeracy literacy skills. This finding is in line with the results of recent studies. A meta-analysis conducted by (Paloloang et al., 2020) found that PBL had an average effect size of 0.830 on students' mathematical literacy skills in Indonesia, which is considered a high number. Similar findings also emerged in a meta-analysis by (Wahyudi, 2024), which reported an average effect size of 1.163 for mathematical abilities and 1.465 specifically for numeracy. When compared to the effect size values in your research,

the increase is much greater than the average of other studies, further reinforcing that PBL is very effective in the context of the class you studied.

From a learning perspective, these results make perfect sense. PBL places students at the center of learning and encourages them to think, explore, discuss, and solve problems directly. According to many recent studies, this learning pattern helps students understand concepts more deeply and makes knowledge easier to apply in new situations. In other words, the large effect size is not just a statistical number, but evidence that a more active learning approach can change the way students understand and use numeracy concepts.

Discussion

The overall results of the study indicate that PBL is effective in improving students' numeracy literacy. This improvement is in line with the principles of constructivist theory, which emphasizes that students build understanding through direct experience, social interaction, and reflection on their thinking processes. Within Vygotsky's framework, problem-solving activities and group discussions in PBL help students move from their actual abilities to their zone of proximal development, so that the knowledge gained becomes more profound and meaningful. Similarly, Bruner asserts that learning that provides opportunities for students to discover and construct concepts on their own will result in stronger conceptual understanding.

The findings of this study are also consistent with the latest empirical evidence. A meta-analysis conducted by (Paloloang et al., 2020) shows that PBL provides a high increase in students' mathematical literacy, with an effect size in the large category. Another study by (Wahyudi, 2024) also reports that PBL significantly improves mathematical ability and numerical literacy, especially when learning is designed based on contextual problems. At the international level, a study by (Yong Liu a, 2022) finds that PBL helps students develop higher-order thinking skills, including the ability to analyze, interpret data, and make decisions based on numerical information.

When compared to these findings, the results of this study show a similar pattern: PBL not only improves test scores, but also helps students understand numeracy concepts in real-world contexts. By providing space for students to explore authentic problems, discuss, and connect learning to everyday life, PBL creates a learning experience that encourages students to process, reason, and interpret number-based information with greater confidence.

CONCLUSION

The researchers concluded that the application of the Problem-Based Learning (PBL) model significantly improved the numeracy literacy of third-grade elementary school students. Data analysis showed that the group of students who learned using the PBL method experienced a higher increase in their ability to solve context-based numeracy problems compared to the group that used conventional methods. The advantage of PBL lies in its ability to encourage students to think critically, analyze problems, and find solutions that are relevant to everyday life. In addition, students who learn with PBL are more motivated, independent in problem solving, and have higher confidence in presenting answers.

Based on these findings, it is recommended that the PBL model be integrated into mathematics learning in elementary schools to improve the quality of learning and students' numeracy skills. With a more interactive and problem-solving-oriented approach, students can develop a deeper understanding of mathematical concepts and apply them effectively in various real-life situations.

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