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The Effectiveness of Implementing the Problem Based Learning Model with a Contextual Approach on Students' Numeracy Literacy Skills

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ABSTRACT

This study is motivated by students' limited numeracy literacy skills, particularly in processing information, solving contextual problems, and evaluating mathematical results. It aims to explore the effects of integrating a Problem-Based Learning model with a contextual method on students' literacy and numeracy skills. A nonequivalent pretest–posttest control group design employing a quasi-experimental method was utilized. The population consisted of all eighth-grade students at SMP Negeri 3 Pattallassang. The sample comprised class VIII.3 as the experimental group and class VIII.2 as the control group, selected using a random sampling technique. Data were collected through observation forms and a numeracy literacy test and were subsequently examined using descriptive and inferential statistics, including normality tests, homogeneity tests, and an independent-samples t-test. The results showed that students' numeracy literacy skills taught using the direct instruction model were at a moderate level, whereas those taught using the problem-based learning model with a contextual approach were at a high level. This indicates a difference in the mean learning outcomes between the two groups. Furthermore, the relative efficiency analysis revealed that the problem-based learning model with a contextual approach was effective in improving the numeracy literacy skills of eighth-grade students at SMP Negeri 3 Pattallassang.

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INTRODUCTION

Education plays a fundamental role in developing high-quality and competitive human capital, particularly in responding to the complex and dynamic challenges of globalization (Makkawaru, 2019). During the era of the ourth industrial revolution and society 5.0, education systems are required to prepare individuals who are not only academically competent but also equipped with critical thinking skills, creativity, collaboration abilities, as well as adequate digital literacy and numeracy. Within this

framework, teachers function not merely as carriers of knowledge but as facilitators who shape students' character, ethics, and global competitiveness (Amalia & Munif, 2023).

In line with these demands, numeracy literacy is an important competency that needs to be developed in the learning process. Numeracy literacy plays a role in helping students understand, interpret, and analyze quantitative information encountered in everyday life (Darmastuti, et al., 2024). This ability not only supports sound decision-making but also forms the basis for solving various contextual problems. One effort to develop numeracy literacy is through meaningful and contextual mathematics learning. Through mathematics learning, students are expected to develop problem-solving skills and communicate ideas or concepts using symbols, tables, diagrams, and other visual representations. According to Tabroni, et al. (2022), numeracy literacy includes the knowledge and skills to (a) use numbers and basic mathematical symbols to solve practical problems in various life contexts and (b) analyze information presented in the form of graphs, tables, or charts and use the results of this analysis to make decisions. Thus, numeracy literacy is not only limited to the ability to count but also includes critical thinking and reasoning skills in dealing with quantitative information in the real world.

However, various national and international assessments indicate that the numeracy literacy abilities of Indonesian students are still quite low. According to the Programme for International Student Assessment (PISA), most Indonesian students have not yet attained the expected level of numeracy proficiency (Poernomo, et al., 2021). The 2018 PISA results placed Indonesia 73rd out of 79 participating countries in numeracy (Nurazizah, et al., 2023). Furthermore, although Indonesia experienced a five-position improvement in the 2022 PISA cycle compared with 2018, this achievement still reflects comparatively low numeracy literacy performance when contrasted with that of other countries (Azhar, et al., 2023).

In addition, the results of a study conducted by Elina, et al. (2024) showed that most students' numeracy literacy skills were at the basic level, even requiring special intervention when working on Minimum Competency Assessment questions, a form of national evaluation in Indonesia designed to measure students' basic abilities, particularly reading and numeracy literacy. Furthermore, Khoirunnisa & Adirakasiwi (2023) found that students' reading and numeracy skills improved by only 37% during the period of independent learning. These findings indicate that students face limitations in numeracy, including difficulties in interpreting information presented in graphs, tables, or other formats, as well as challenges in analyzing data for problem-solving. Overall, these results highlight the gap between the competencies demanded by 21st-century education and students' actual abilities.

Based on the results of an interview with one of the mathematics teachers at SMP Negeri 3 Pattallassang, it was found that, in general, students have relatively good basic mathematical operational skills. However, they tend to easily forget material that has been learned and often need to be reminded by the teacher. In the context of numeracy literacy, students are able to solve problems involving systems of equations when presented directly. However, they experience difficulties when the problems are presented in story or contextual forms. The main difficulty lies in their ability to understand information from reading and transform it into mathematical form. This weakness indicates that the aspects of reading, interpreting, and modeling information into mathematical form remain major challenges. This condition makes SMP Negeri 3 Pattallassang ((State Junior High School 3 Pattallassang) a relevant research location because it represents common problems faced by students in learning mathematics, particularly related to numeracy literacy. Therefore, this study focuses on examining more deeply the numeracy literacy abilities of students in this context.

To obtain an overview of these abilities, the researchers administered two numeracy literacy test items on the subject of systems of linear equations in two variables (SLETV). The selection of SLETV material was based on its characteristics, which require mathematical modeling skills from contextual problems, making it highly relevant for measuring students' numeracy literacy abilities, particularly in the aspects of understanding problems, representing them in the form of equations, and solving them systematically.

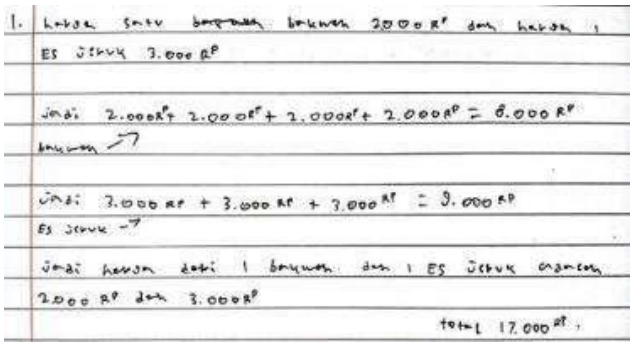

Figure 1. Answers to Question No.1 Numeracy Literacy

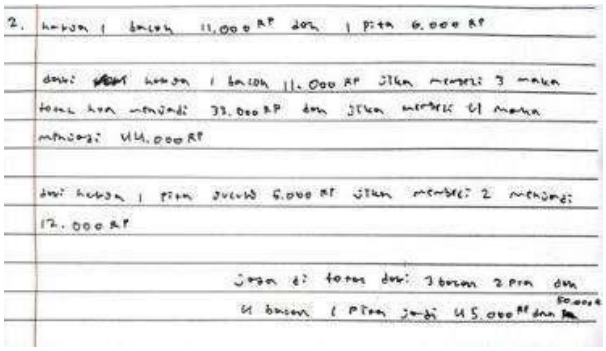

Figure 2. Answers to Question No.2 Numeracy Literacy

According to the researcher's observations in Class VIII.2 while working on test question number one, up to 13 students were able to actively and enthusiastically engage in solving the problems. However, the students did not demonstrate advanced numeracy and literacy skills. Only a few students were able to complete test question number two within the allotted time, achieving six correct answers and three incorrect answers. Students generally relied on basic arithmetic operations, such as addition, to find solutions without first constructing a mathematical model or system of equations based on the presented narrative.

These conditions indicate that ongoing mathematics learning has not fully developed students' numeracy literacy skills, particularly in understanding and modeling contextual problems. Learning that is still oriented toward the delivery of procedures and the solution of routine problems tends to provide less space for students to optimally develop critical thinking and problem-solving skills (Rosida, 2025). Therefore, innovations in mathematics learning are needed that not only emphasize the mastery of concepts and procedural skills but also develop logical, critical, and analytical thinking skills relevant to real life. These innovations should be designed holistically and in an integrated manner so as to improve the overall quality of students' literacy and numeracy.

The Problem-Based Learning (PBL) approach is frequently identified as an effective strategy for addressing these challenges. PBL places students in real-world situations that require them to identify problems, collect relevant information, and develop solutions through both collaborative and independent activities. This strategy allows students to actively engage in the learning process while also enhancing their critical thinking and problem-solving ability, both of which are essential for developing numeracy literacy skills (Masliah & Nirmala, 2023). Arends describes Problem-Based Learning as an instructional method that immerses students in authentic problems, enabling them to construct their own knowledge, develop higher-order thinking and inquiry skills, and cultivate independence and self-confidence (Erawati, 2022).

Although PBL theoretically uses contextual problems as a starting point for learning, in practice, the context presented is not always directly related to students' real-life experiences. PBL places greater emphasis on the process of inquiry and problem-solving, so that aspects of personal connection and the meaningfulness of the context for students are not necessarily optimally facilitated. Therefore, an approach is needed that explicitly directs learning to connect with students' real-life experiences. In this case, the Contextual Teaching and Learning (CTL) approach is considered relevant because it emphasizes the connection between learning materials and real-life contexts, thereby helping students understand, interpret, and model problems more meaningfully. CTL is a learning concept that encourages teachers to link subject matter to real-life situations faced by students, with the aim of enabling them to build connections between the knowledge gained in school and its application in everyday life. This approach positions students as active participants in the learning process, making learning activities more productive and meaningful (Aisyah, et al., 2022). Furthermore, CTL is also understood as an approach that enables students to connect academic knowledge with their roles in life as family members, community members, and citizens. This aligns with the view of the US Department of Education that contextual learning helps students understand the relevance of material to real life and supports the development of applicable skills in social settings. Furthermore, MKDP (2007) states that the core of the contextual approach lies in the connection between learning materials and the realities of students' daily lives (Sunaryo & Fatimah, 2018).

Conceptually, CTL is based on constructivist theory, which views knowledge as actively constructed by students through experience and interaction with the environment (Aden, et al., 2025). Thus, students act not only as recipients of information but as individuals who actively construct knowledge and develop critical thinking, reflection, and problem-solving skills in real-world contexts. Therefore, the integration of PBL with the CTL approach is expected to produce learning that not only encourages critical thinking and problem-solving skills but also increases the meaningfulness and relevance of learning for students.

Various studies have supported the effectiveness of the PBL model in improving students' literacy and numeracy skills. Research by Masliah & Nirmala (2023) showed that PBL is more effective than conventional learning, as evidenced by higher average student literacy and a significant increase in N-gain. This finding aligns with research by Farhan, et al. (2022), which showed that students' mathematical literacy skills taught using PBL were higher than those in control classes and was supported by increased student learning activities. Furthermore, Wibowo, et al. (2022) and Asri & Maysarah (2025) found that PBL is superior to other models, such as Discovery Learning, in

improving students' numeracy skills. Other studies have also shown that the effectiveness of PBL can be enhanced through integration with various learning approaches and media, such as the use of digital media (Ambarwati & Kurniasih, 2021), the TPACK approach (Rachman & Nuriadin, 2022), and scaffolding strategies (Fathurrohman & Putra, 2024), which have generally been shown to improve students' numeracy literacy skills and learning engagement. Furthermore, Awami, et al. (2022) confirmed that PBL is effective in improving numeracy literacy, although it is influenced by other factors such as self-confidence.

However, most of these studies focus on the implementation of PBL as the primary model or in combination with other media and approaches. They have not specifically integrated PBL with learning approaches that emphasize direct connections to students' real-life experiences, such as CTL. Therefore, this study presents a novel approach by integrating the PBL model with the CTL approach in mathematics learning. This approach emphasizes not only problem-solving skills but also the meaningfulness of the learning context. This is expected to improve students' ability to understand, interpret, and model contextual problems more effectively. Based on this description, this study aims to analyze the effectiveness of implementing the PBL model combined with a contextual approach in improving students' numeracy literacy skills.

METHOD

This research was conducted in classes VIII.2 and VIII.3 of SMP Negeri 3 Pattallassang in Gowa Regency (State Junior High School 3 Pattallassang), during the first semester (Odd) of October. The research design used was a quasi-experimental design, with the population comprising all eighth-grade students of SMP Negeri 3 Pattallassang. In this study, sampling was carried out using a random sampling technique to ensure that each class had an equal opportunity to be selected, so that the experimental and control groups were more comparable and the research results were more representative, namely class VIII.2 as the control class and class VIII.3 as the experimental class, each consisting of 24 students.

The following data gathering strategies were used in this investigation: 1) a numeracy literacy competency test and 2) observation of learning implementation. The tests consisted of pretests and posttests, both in the form of essay questions using identical indicators. The indicators were: (1) applying basic mathematics-related numbers or symbols to solve everyday problems, (2) the capacity to comprehend information provided in various formats (graphs, tables, charts, diagrams, etc.); and (3) evaluating analytical results to forecast and make judgments (Han, et al., 2017). The categorization

of numeracy literacy abilities followed the frameworks proposed by Yuhana & Ashif (2025) dan Heriyanti, et al. (2023).

Meanwhile, observations of learning implementation were used as evaluation material to improve the quality of learning, making it more effective and aligned with the expected objectives. The test instrument was validated by experts and tested prior to use. The test instrument was considered valid according to experts and calculated using the Gregory technique, as explained by Meivinia (2023) and Fitriah (2019), and refers to the validity criteria according to Guilford (Rahmawati & Apsari, 2019). The results of the validity test using IBM SPSS Statistics version 25 showed that all pretest and posttest items had a calculated r > r table (0.413), falling within the valid to very high category. The reliability test produced a Cronbach's Alpha value of 0.922 for the pretest and 0.900 for the posttest, both of which are classified as very high. Thus, the test instrument can be considered valid and reliable for measuring students' numeracy literacy skills.

This study collected data using the final test research instrument. To analyze the research data, a hypothesis test was conducted. Prior to conducting the hypothesis test, prerequisite analyses, including tests of normality and homogeneity, were performed. The findings of the experimental and control groups were compared using an Independent Sample t-test with a significance threshold of $\alpha = 0.05$.

RESULTS AND DISCUSSION

The study utilized data obtained from a numeracy literacy test administered to Grade VIII students at SMP Negeri 3 Pattallassang, with a total sample of 48 students.

Table 1. Descriptive Values of Pretest and Posttest Results in Control and Experimental Classes

Descriptive Statistics						
Class	Sample	Minimun Score	Maximum Score	*Mean*	Standard Deviation	Variance
Control Pretest	24	14	30	21,20	5,090	25,911
Control Posttest	24	45	86	63,75	13,355	178,370
Experimental Pretest	24	14	31	22,37	5,822	33,897
Experimental Posttest	24	47	90	71,58	11,77	138,601

Table 1 indicates that, in the control group, pretest scores ranged from 14 to 30, with a mean score of 21.20. The data showed moderate dispersion, as reflected by a standard deviation of 5.090 and a variance of 25.911. Following the posttest, scores increased to a range of 45 to 86, with the mean rising to 63.75. The variability of scores also increased, as indicated by a standard deviation of 13.355 and a variance of 178.370. The pretest scores for the experimental group ranged between 14 and 31, with an average

of 22.37, a standard deviation of 5.822, and a variance of 33.897. The posttest scores ranged from 47 to 90, with the mean rising to 71.58, standard deviation 11.77, and variance 138.601.

Following the presentation of descriptive data, hypothesis testing was conducted to evaluate students' numeracy and reading abilities. Prior to this, a precondition analysis, including normality and homogeneity tests, was performed. The Shapiro-Wilk test was employed at a 5% level of significance to see if the data followed a normal distribution. When the significance threshold exceeds 0.05, H_0 is accepted, indicating that the data is normally distributed. If the significance level is less than 0.05, H_0 is rejected, indicating that the data is not normally distributed.

Table 2. Depicts the Normalcy Test of Students' Numeracy Literacy Skills in the Experimental and Control Groups

Normality Test				
	Class	Shapiro-Wilk		
		Statistic	*Df*	Sig.
Numeracy Literacy Skills	*Experimental Pretest*	0,937	24	0,141
	Experimental Posttest	0,929	24	0,093
	Control Pretest	0,920	24	0,058
	Control Posttest	0,957	24	0,379

Based on the decision-making criteria, the normality test results indicate that H_0 is accepted, as the significance level exceeds 0.05. This suggests that the sample was chosen from a suitably dispersed population. The data was then examined for homogeneity to see whether it had equal variance. H_0 is accepted when the significance value surpasses 0.05, indicating equal variance or homogeneity in the data.

Table 2 shows that the significance levels for the pretest and posttest results for both the experimental and control groups were more than 0.05. Accordingly, the hypothesis H_0 was accepted, indicating that the pretest and posttest results in both classes had a normal distribution. The data were then subjected to a homogeneity test to determine whether they originated from populations with equal variance. The decision criteria are as follows: if the significance value is less than 5%, H_0 is rejected, indicating unequal variances; however, if it exceeds 5%, H_0 is accepted, indicating equal variances.

Table 3. Displays The Results Of the Posttest Homogeneity Test For Students In the Experimental and Control Groups

Homogeneity Test			
Numeracy Literacy Skills	*Equal Variances Assumed*	*F*	*Sig.*
		1,156	0,288

The homogeneity test in Table 3 produces a significant value of 0.288 under the Equal Variances Assumed condition, which exceeds the alpha criterion of 0.05. As a consequence, the null hypothesis is accepted, meaning that the data variances in the experimental and control groups are comparable or homogeneous.

After confirming that all data met the normality and homogeneity requirements, hypotheses were tested. An independent sample t-test with a significance threshold of 0.05 was used to compare the experimental and control groups. The null hypothesis is rejected if the p-value is less than 0.05, which shows that the mean numeracy literacy scores of the two groups differ significantly. If the p-value is greater than 0.05, the null hypothesis, which states that there is no significant difference between the groups, is accepted.

Table 4. Independent Samples T-Test Results

Independent Samples T-Test						
		Levene's Test for Equality Of Variances		t-test for Equality of Means		
Numeracy Literacy Skills		F	Sig.	T	*Df*	Sig. (2-tailed)
	Equal variances assumed	1,156	0,288	2,155	46	0,036
	Equal variances not assumed			2,155	45,287	0,036

According to the Independent Sample t-test results reported in Table 4, the Sig. (2-tailed) value is 0.036, which is less than the alpha threshold of 0.05. Therefore, the null hypothesis is rejected. This research demonstrates a significant difference in the mean numeracy literacy abilities of students taught utilizing the PBL model with a contextual approach versus direct teaching. An effectiveness test was also conducted to evaluate the performance of the PBL model in a contextual setting. The relative efficiency formula was employed with the following criteria: if R > 1, then $\hat{\theta}_2$ (PBL model with a contextual approach) is more efficient than $\hat{\theta}_1$ (direct learning model); if R < 1, then $\hat{\theta}_1$ is more efficient than $\hat{\theta}_2$.

$$R\left(\hat{\theta}_2, \hat{\theta}_1\right) = \frac{Var\ \hat{\theta}_1}{Var\ \hat{\theta}_2} = \frac{178{,}370}{138{,}601} = 1{,}286$$

Based on the calculations above, R was found to be 1.286. Since $R > 1$, $\hat{\theta}_2$ is relatively more efficient than $\hat{\theta}_1$. This finding indicates that the Problem-Based Learning

paradigm, along with a contextual approach, is effective in improving Grade VIII students' numeracy literacy skills at SMP Negeri 3 Pattallassang.

The implementation of direct instruction in Grade VIII at SMP Negeri 3 Pattallassang was highly effective, achieving 96.7%. All components of the direct instruction model, including setting objectives, explaining concepts, guided practice, and independent practice, were applied consistently. This reflects the teacher's ability to manage the class and deliver knowledge systematically, aligning with the core characteristics of direct instruction, which emphasize structured and clear information delivery (Tanjung et al., 2025). However, variations were observed in student engagement throughout the learning process, with some students actively participating in explanations and activities, while others remained passive and quickly lost focus. This finding aligns with Asyva, et al. (2025), who suggested that the effectiveness of direct instruction is strongly influenced by students' preparedness and attentional capacity.

The results of the numeracy literacy test showed an average score of 63.75 for the control class, which falls into the medium category, with 12 students in the medium category, 9 in the high category, and 3 in the very high category. The predominance of the medium category indicates that most students still solve problems procedurally without in-depth conceptual understanding, particularly in interpreting analysis results and making decisions. In contrast, students in the high and very high categories are able to construct mathematical models correctly and carry out solving procedures systematically. This phenomenon aligns with Wardani, et al. (2025), who stated that direct learning tends to be more dominant in developing procedural abilities than contextual reasoning abilities.

Analysis of numeracy literacy indicator performance revealed an imbalance between procedural and conceptual aspects. The control class demonstrated high performance in indicator 1, namely the ability to use basic mathematical symbols or numbers to solve everyday life problems (average score of 65.83), and in indicator 2, the ability to analyze information presented in various formats, such as graphs, tables, charts, and diagrams (average score of 66.67). However, indicator 3, namely the ability to interpret analysis results to predict or make decisions based on the problem context, achieved a medium score (57.78). These findings reinforce the theory of numeracy literacy, which emphasizes the importance of connecting mathematical procedures to real-world contexts (Ramadhani, 2025). In other words, although students are able to calculate and analyze data procedurally, they are not yet consistently able to transfer their knowledge to contextual situations.

This limitation is also reflected in the direct learning process itself. This learning model emphasizes the sequential delivery of material and structured exercises but

provides little space for higher-order thinking, open discussion, or conceptual reflection. As a result, passive or easily distracted students receive less cognitive stimulation to develop in-depth understanding (Asyva, et al., 2025; Tanjung, et al., 2025). This suggests that the effectiveness of direct learning is determined not only by the implementation of its syntax but also by differentiation strategies, student motivation, and the teacher's ability to relate the material to everyday life contexts. Therefore, integrating a contextual or problem-based learning approach can be an alternative for improving students' numeracy literacy skills, particularly in the aspects of interpretation and decision-making.

However, Implementation of the PBL model with a contextual approach in the experimental class was highly effective, achieving a 97.31% success rate. All stages of PBL were executed systematically, emphasizing the presentation of authentic problems and group discussions. Ningsih, et al. (2025) and Yulianti & Gunawan (2019) demonstrated that real-world contextual challenges can enhance students' cognitive engagement and learning motivation. According to the social constructivist approach, group discussions enable students to construct knowledge collaboratively while simultaneously developing cooperative problem-solving skills (Salsabila & Muqowim, 2024).

The posttest results showed a significant increase in students' numeracy literacy skills, with an average of 71.58, higher than the control class. Of the 24 students, 5 students (20.83%) were in the medium category, 14 students (58.34%) in the high category, and 5 students (20.83%) in the very high category. The predominance of the high and very high categories indicates that most students were able to write down information completely, build context-appropriate mathematical models, carry out solution procedures correctly, and interpret results logically. This finding is consistent with Awami, et al. (2022) and Rachman & Nuriadin (2022), who stated that PBL is effective in improving numeracy literacy because it positions students as active problem solvers. This also confirms the principle of numeracy literacy, which emphasizes students' ability to connect mathematical concepts to real contexts and make data-based decisions.

Analysis of numeracy literacy indicators in the experimental class showed a better balance between procedural and conceptual aspects. Indicators for the use of basic mathematical symbols and information analysis achieved high scores of 76.11 and 74.79, respectively, while the interpretation and decision-making indicator increased to 62.78, falling into the medium category. These results indicate that PBL not only strengthens procedural skills but also fosters students' conceptual abilities to interpret results, make predictions, and make decisions based on the problem context. Active participation, connecting the material to real-life situations, and group reflection activities are key factors in this success, as emphasized by Awami, et al. (2022) who emphasize that

students' direct involvement in problem-solving improves conceptual understanding and critical thinking skills, and Rachman & Nuriadin (2022), who add that collaboration in group discussions strengthens mathematical communication skills and transfers knowledge to real-world contexts.

However, PBL has limitations that require attention. Some students take longer to construct mathematical representations due to their lack of familiarity with open-ended problems, while group dynamics are sometimes unbalanced, leading to the predominance of some members' contributions. These limitations emphasize the need for teacher scaffolding, the provision of relevant contextual media, and adaptive group management to ensure optimal participation by all students (Anggraini, et al., 2025). Theoretically, this phenomenon aligns with numeracy literacy, which emphasizes that students' ability to connect symbols, procedures, and real-world contexts requires explicit guidance, social interaction, and appropriate cognitive stimulation. Therefore, although PBL has been shown to improve numeracy literacy better than direct instruction, its implementation must be designed with differentiation strategies, individual progress monitoring, and collaborative reflection to ensure a balanced development of conceptual and procedural skills.

The results of the Independent Sample t-test showed a significant difference in numeracy literacy skills between the control and experimental classes, with the experimental class's average score being higher (71.58) than the control class's (63.75). This difference is not only numerical but can also be explained conceptually. The experimental class, which implemented the PBL model with a contextual approach, demonstrated higher cognitive engagement because students were actively confronted with authentic problems relevant to everyday life. This learning process encouraged students to independently construct mathematical models, analyze information, interpret calculation results, and make decisions based on the context of the problem, thus developing their conceptual skills better than students in the control class, which used direct instruction.

Analysis of numeracy literacy indicator achievement supports this finding. In the control class, students demonstrated high scores on the indicators for symbol use and information analysis, but their scores on the interpretation and decision-making indicator were still in the medium category (57.78), indicating a predominance of procedural aspects and limitations in conceptual understanding. In contrast, in the experimental class, all indicators, including interpretation and decision-making, showed high achievement (62.78), indicating that PBL promotes the development of conceptual understanding in a more balanced manner. This finding aligns with Darwati & Purana (2021) and Wicaksana, et al. (2025), who stated that PBL is more effective than direct learning in developing

higher-order thinking skills because students are directly involved in problem-solving, group discussions, and reflection.

Conceptually, this difference in ability arises from the distinct characteristics of the two learning models. In PBL, real-world problem contexts require students to relate mathematical concepts to everyday situations, develop solution strategies, and evaluate the results. The social interactions that occur in group discussions strengthen conceptual understanding through the exchange of ideas, clarification, and argumentation, in accordance with the principles of social constructivism. In contrast, direct learning tends to position students as recipients of information; thinking activities are limited to solution procedures, resulting in medium interpretation and decision-making skills. This is supported by research by Awami, et al. (2022) and Rachman & Nuriadin (2022), which emphasize that active participation, linking material to real life, and group reflection are key factors in improving numeracy literacy because they facilitate the development of conceptual understanding, critical thinking, and knowledge transfer.

Thus, the superior numeracy literacy in the experimental class is not solely a result of the learning procedures but also a consequence of active student involvement, context-based problem solving, social collaboration, and teacher facilitation that supports in-depth exploration of concepts. Meanwhile, the limitations of direct learning in encouraging conceptual understanding emphasize the importance of implementing a more interactive and contextual learning model to develop numeracy literacy optimally.

Based on the relative efficiency test, the r value obtained indicates that the application of PBL with a contextual approach is quite effective in improving numeracy literacy skills. This effectiveness occurs because PBL not only provides space for students to construct knowledge independently but also encourages them to link mathematical concepts to real contexts, develop problem-solving strategies, and interpret results meaningfully. Active involvement in group discussions, reflection on the problem-solving process, and the opportunity to test and revise ideas collaboratively help students understand concepts more deeply and develop higher-order thinking skills (Darwati & Purana, 2021; Wicaksana, et al., 2025). These results are in line with research by Tanjung, et al. (2025), Rachman & Nuriadin (2022), Chudin & Retnawati (2025), and Simarmarta, et al. (2025), which consistently report that the PBL model is more effective than direct learning in improving students' literacy and numeracy.

According to Nasution, et al. (2025), the PBL model effectively enhances student engagement and learning outcomes through systematic problem-solving stages. Similarly, Rachman and Nuriadin (2022) reported that the PBL model integrated with the TPACK approach improved students' literacy and numeracy skills by fostering critical thinking and information processing. Chudin & Retnawati (2025) found that applying

PBL, particularly when combined with the STEAM approach, moderately enhances numeracy skills. Additionally, Simarmata, et al. (2025) demonstrated that PBL outperforms traditional instruction in developing numeracy skills in quadratic equations, with the group that applied the PBL method achieved a higher average N-Gain score than the group that did not. Taken together, these findings indicate that the implementation of PBL contributes to improvements in students' reading and mathematical skills.

CONCLUSION

Based on the research results, the numeracy literacy skills of students in the control class using direct learning are in the medium category with an average value of 63.75, while the experimental class using Problem-Based Learning (PBL) with a contextual approach is in the high category with an average value of 71.58. The results of the comparison test show that PBL is more effective in improving numeracy literacy than direct learning, further research is recommended to explore the combination of PBL with other learning strategies, the effect of implementation duration, and adaptation for various levels of student ability to examine the consistency and generalization of the effectiveness of this model.

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