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# Effectiveness of Problem-Based Learning for Numeracy Across Self-Efficacy Levels Among Fifth-Graders at SDN 13 Andoolo

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**Abstract:** Effective numeracy instruction requires contextual learning that also addresses students' confidence. This study described students' self-efficacy, examined the effectiveness of Problem-Based Learning (PBL) for numeracy skills, and compared numeracy across self-efficacy categories. A quantitative pre-experimental one-group pretest-posttest design involved 10 fifth-grade students at SD Negeri 13 Andoolo. Data from a numeracy test and self-efficacy questionnaire were analyzed using descriptive statistics, normalized gain (N-gain), the Shapiro-Wilk test, a paired-samples t-test, and an independent-samples t-test. The mean self-efficacy score was 63.9; 6 students (60%) were in the high category and 4 (40%) in the low category. The mean numeracy score increased from 49.8 at pretest to 79.2 at posttest, yielding a moderate N-gain of 0.59. The paired-samples test produced a significance value of 0.000 < 0.05. The high-self-efficacy group had a higher mean posttest score (82.67) than the low-self-efficacy group (74.00), and the difference was significant (p = 0.015). PBL was therefore effective for numeracy within the group studied, although differences by self-efficacy require cautious interpretation because the subgroups were small.

**Keywords:** Problem-Based Learning, Numeracy Skills, Self-Efficacy, Elementary School

## INTRODUCTION

Numeracy is the ability to understand and use numbers, arithmetic operations, data representations, and quantitative reasoning to solve problems across a range of real-life contexts. At the elementary level, this ability cannot be developed solely through mastery of procedures; students also need experience in interpreting information, selecting strategies, performing calculations, and explaining the meaning of their results. Numeracy therefore provides a foundation for the development of mathematical problem-solving and decision-making skills. Research involving elementary school students has shown that instruction connecting mathematical problems to real-world contexts can improve numeracy skills (Astutik, 2022; Maulida, 2025).

Mathematics instruction centered on routine exercises tends to provide students with limited opportunities to identify problems, evaluate alternative solutions, and reflect on the reasoning behind an answer. Consequently, students may succeed on problems similar to worked examples yet struggle with nonroutine or contextual problems. Studies of numeracy instruction likewise emphasize the importance of learning models that foster active engagement, reasoning, communication, and

problem solving, rather than merely transmitting procedures from teachers to students (Siswanto et al., 2025; Sutrimo et al., 2024).

Problem-Based Learning (PBL) addresses these needs by using authentic problems as the starting point for learning. In PBL, students are guided to understand the problem situation, organize information, conduct investigations, develop and present solutions, and evaluate the problem-solving process. These stages allow students to connect mathematical concepts with meaningful situations. The teacher acts as a facilitator who provides guiding questions and support as needed, while students construct understanding through individual and collaborative activities. Lestari et al. (2024) found that problem-based learning affected elementary students' mathematics learning outcomes.

In the context of numeracy, the value of PBL lies in the direct connection between contextual problems and mathematical processes. Students are expected not only to arrive at an answer but also to select relevant information, determine appropriate operations, assess the reasonableness of their results, and communicate their solutions. Astutik (2022) reported improved numeracy skills through PBL among elementary school students, while Maulida (2025) examined the effect of PBL on numeracy literacy. More broadly, the review by Siswanto et al. (2025) identified PBL as a model that supports mathematical problem solving. This evidence demonstrates the potential of PBL, although its effectiveness remains associated with learner characteristics and the implementation context.

One affective characteristic associated with mathematics learning is self-efficacy, defined as students' belief in their ability to organize their actions and complete the tasks they face. Self-efficacy influences strategy selection, effort, persistence when difficulties arise, and willingness to try again after making mistakes. Fitriani and Pujiastuti (2021) found that self-efficacy influenced mathematics learning outcomes, while Marasabessy (2020) demonstrated its association with mathematical problem-solving ability. Afifah and Kusuma (2021) likewise identified self-efficacy, together with critical thinking ability, as an important aspect of mathematics learning.

PBL and self-efficacy have a mutually reinforcing pedagogical relationship. Challenging yet attainable problems, peer support, teacher guidance, and opportunities to present solutions can provide students with successful learning experiences. Such experiences may strengthen their confidence in approaching subsequent tasks. Herzamzam (2021) reported increased motivation and self-efficacy through problem-based learning among elementary school students. Pratama (2024) also associated PBL with mathematical problem solving and self-efficacy. Conversely, students with low self-efficacy may require more targeted scaffolding to prevent the demands of problem solving from prompting task avoidance.

Preliminary observations at SD Negeri 13 Andoolo indicated that fifth-grade mathematics instruction continued to emphasize routine exercises. Students had limited opportunities to discuss contextual problems, develop their own strategies, and explain the reasoning behind their solutions. At the same time, students varied in their confidence when confronting problems they perceived as difficult. Previous studies have generally examined the cognitive outcomes of PBL or discussed self-efficacy separately. No study has simultaneously described improvements in numeracy and compared outcomes by self-efficacy category among fifth-grade students at SD Negeri 13 Andoolo.

This study contributes classroom-level evidence on changes in numeracy skills before and after PBL while also describing variations in outcomes by self-efficacy level. Because the study involved a single group and a limited number of participants, it was not intended to support broad generalizations or establish a causal relationship between self-efficacy and numeracy. The study aimed to describe the self-efficacy profile of fifth-grade students at SD Negeri 13 Andoolo, examine the effectiveness of PBL in improving numeracy skills, and identify differences in numeracy skills between students with high and low self-efficacy.

## METHOD

This study used a quantitative approach with a pre-experimental one-group pretest-posttest design. It was conducted at SD Negeri 13 Andoolo. The population comprised all fifth-grade students, and all 10 members of the population participated in the study. The use of a single group was determined by the number of students and the available classroom conditions. The research design included an initial assessment of numeracy skills, an intervention using PBL, and a final assessment of numeracy skills.

PBL was the independent variable and numeracy skills were the dependent variable, while self-efficacy served as a grouping variable. The intervention was implemented in five stages: orienting students to contextual problems, organizing students for learning, guiding individual or group investigations, developing and presenting problem solutions, and analyzing and evaluating the solution process. The pretest was administered before the intervention and the posttest after the instructional sequence had been completed. The self-efficacy questionnaire was administered after instruction to obtain a profile of students' confidence in learning mathematics.

The numeracy instrument consisted of five constructed-response items assessing students' ability to understand contextual problems involving numbers, apply mathematical concepts and procedures, and interpret the results of their solutions. The self-efficacy instrument consisted of 20 statements rated on a four-point Likert scale:

strongly agree, agree, disagree, and strongly disagree. The statements addressed confidence in understanding mathematical content, confidence in solving problems, and persistence in learning. The questionnaire blueprint was developed with reference to the source used in the thesis (Dzakiyah, 2024). Self-efficacy scores were classified using the overall mean: scores equal to or above the mean were categorized as high, whereas scores below the mean were categorized as low.

Descriptive analysis included the number of participants, minimum score, maximum score, mean, and category percentages. Improvement in numeracy skills was calculated using normalized gain (N-gain), categorized as high for values of at least 0.70, moderate for values from 0.30 to less than 0.70, and low for values below 0.30. The normality of the pretest and posttest scores was assessed using the Shapiro-Wilk test because the number of participants was fewer than 30. Differences between pretest and posttest scores were analyzed using a paired-samples t-test, while differences in posttest scores by self-efficacy category were analyzed using an independent-samples t-test. All tests were conducted at the 0.05 significance level using SPSS version 20.

The interpretation of effectiveness was limited to changes within the study group because the design did not include a control group. Comparisons by self-efficacy were also treated as exploratory analyses between subgroups. Accordingly, differences between categories indicate score variation within the sample rather than evidence that self-efficacy alone caused changes in numeracy skills.

## RESULTS AND DISCUSSION

### Results

*Students' self-efficacy profile*

The self-efficacy scores of the 10 students ranged from 50 to 75, with a mean of 63.9. Using this mean as the cutoff, 6 students were classified in the high category and 4 in the low category. The distribution and mean for each category are presented in Table 1.

**Table 1. Distribution of Student Self-Efficacy Categories**

| Category | n | Percentage | Mean score |
|---|---|---|---|
| High | 6 | 60% | 70.67 |
| Low | 4 | 40% | 53.75 |
| Overall | 10 | 100% | 63.90 |

Table 1 shows that most students were in the high self-efficacy category. Nevertheless, the presence of 4 students in the low category indicates that support for students' confidence remains necessary. The mean scores of the high and low groups differed by 16.92 points, consistent with the use of the overall mean as the classification cutoff.

*Numeracy skills before and after PBL*

Changes in numeracy skills were determined by comparing pretest and posttest scores. Descriptive statistics and N-gain results are summarized in Table 2.

**Table 2. Pretest, Posttest, and N-Gain Results for Numeracy Skills**

| Measure | n | Minimum | Maximum | Mean | Description |
|---|---|---|---|---|---|
| Pretest | 10 | 40 | 60 | 49.80 | Baseline ability |
| Posttest | 10 | 70 | 88 | 79.20 | After PBL |
| Difference | 10 | 28 | 30 | 29.40 | Score increase |
| N-Gain | 10 | 0.50 | 0.70 | 0.59 | Moderate |

The mean numeracy score increased by 29.4 points, from 49.8 to 79.2. Every student obtained a higher posttest score than pretest score. A total of 9 students achieved a moderate N-gain and 1 student achieved a high N-gain. The mean N-gain of 0.59 indicated improvement in the moderate category.

*Assumption testing and PBL effectiveness*

The Shapiro-Wilk test was used to examine the distributions of the pretest and posttest scores. As shown in Table 3, both significance values were greater than 0.05.

**Table 3. Shapiro-Wilk Normality Test Results**

| Data | Statistic | df | Sig. | Decision |
|---|---|---|---|---|
| Pretest | 0.976 | 10 | 0.939 | Normal |
| Posttest | 0.965 | 10 | 0.846 | Normal |

Because the pretest and posttest data met the normality assumption, their difference was analyzed using a paired-samples t-test. The results based on individual scores are presented in Table 4.

**Table 4. Paired-Samples t-Test Results for Numeracy Skills**

| Comparison | Mean difference | t | df | Sig. (two-tailed) | Decision |
|---|---|---|---|---|---|
| Pretest-posttest | -29.40 | -110.250 | 9 | 0.000 | Significant |

The significance value of 0.000 < 0.05 indicated a difference in numeracy skills before and after the intervention. Together with the increase in the mean score and N-gain, this result supports the effectiveness of PBL in improving numeracy skills within the group studied.

*Numeracy skills by self-efficacy level*

Mean numeracy scores were subsequently calculated by self-efficacy category. The high-self-efficacy group had higher mean pretest and posttest scores than the low-self-efficacy group, as shown in Table 5.

**Table 5. Numeracy Skills and Difference Test Results by Self-Efficacy Level**

| Group/analysis | n | Mean pretest score | Mean posttest score | t | df | Sig. |
|---|---|---|---|---|---|---|
| High self-efficacy | 6 | 53.33 | 82.67 | - | - | - |
| Low self-efficacy | 4 | 44.50 | 74.00 | - | - | - |
| Posttest t-test | - | - | - | 3.087 | 8 | 0.015 |

The independent-samples t-test on posttest scores yielded t(8) = 3.087 and p = 0.015 < 0.05. Thus, posttest scores differed between the high- and low-self-efficacy groups. The high group achieved a mean posttest score of 82.67, whereas the low group achieved 74.00. However, the high group also had a higher mean pretest score (53.33 versus 44.50). The groups had nearly identical mean raw-score gains of 29.33 and 29.50 points, while their mean N-gain values were 0.64 and 0.54, respectively.

**Discussion**

*Self-efficacy in mathematics learning*

Most students were in the high self-efficacy category, and the overall mean score was 63.9. This finding indicates that most students were confident in their ability to understand the material, solve problems, and persist when facing difficulties. Such

confidence is important in mathematics learning because numeracy problems require students to try different strategies, identify errors, and repeat the solution process. Fitriani and Pujiastuti (2021) associated self-efficacy with mathematics learning outcomes, while Marasabessy (2020) emphasized its association with mathematical problem solving.

The PBL context may help explain why most students demonstrated high self-efficacy. Problem orientation provides a clear purpose; group discussion offers social support; investigation creates opportunities to attempt solutions; and presenting solutions provides experiences of success. Herzamzam (2021) showed that problem-based learning can enhance elementary school students' motivation and self-efficacy. Pratama (2024) likewise examined self-efficacy alongside problem-solving ability in the implementation of PBL. Nevertheless, 40% of the students remained in the low category. Teachers should therefore ensure that problems are not excessively difficult, provide guiding questions, and offer feedback on the process rather than only on final answers.

*Effectiveness of PBL in improving numeracy skills*

The increase in the mean score from 49.8 to 79.2, together with an N-gain of 0.59 and a significant paired difference, indicates a change in numeracy skills following PBL. All students improved, with relatively consistent score differences. Pedagogically, this change can be understood in relation to the characteristics of PBL, which engages students with contextual problems and encourages them to identify known and required information, select procedures, and explain their results. This process aligns with the numeracy test indicators used in the study.

This finding supports Astutik's (2022) results on improving numeracy through PBL and Maulida's (2025) investigation of PBL for enhancing numeracy literacy. It is also consistent with Lestari et al. (2024), who found that problem-based learning affected fourth-grade students' mathematics learning outcomes, and with the review by Siswanto et al. (2025), which demonstrated the role of PBL in optimizing mathematical problem solving. The studies share an emphasis on student engagement in investigation and problem solving, while the present study specifically measured numeracy among fifth-grade students.

The moderate N-gain suggests that PBL produced meaningful progress but did not yield the maximum possible improvement. Teachers may strengthen its impact by designing problems with graduated levels of difficulty, allowing time for reflection, and using a wider range of representations, such as tables, images, and everyday situations. The conclusion that PBL was effective in this study must be limited to the observed

group. Without a control group, changes in scores cannot be compared with progress that might have occurred under other instructional models.

*Differences in numeracy skills by self-efficacy level*

The high-self-efficacy group achieved a higher mean posttest score, and the between-group difference was significant. This finding is consistent with the view that students who are confident in their abilities tend to persist longer, select strategies more readily, and continue their efforts when an initial solution is unsuccessful. Afifah and Kusuma (2021) emphasized the importance of mathematical self-efficacy alongside critical thinking ability, while Nafi et al. (2025) discussed the relationship between self-efficacy and mathematics learning outcomes.

However, the posttest difference cannot be attributed directly to self-efficacy. The high-self-efficacy group already had a higher mean pretest score, while the raw-score gains of the two groups were nearly identical. This pattern indicates that differences in initial ability also contributed to the posttest difference. In addition, the categories were formed from only 10 students, resulting in group sizes of 6 and 4. The result is therefore more appropriately interpreted as variation in numeracy skills associated with self-efficacy categories within the sample, rather than evidence of a moderating role or a causal relationship. Future research could use a larger sample and analyses that control for baseline scores.

In practical terms, PBL should be implemented alongside differentiated affective support. For students with low self-efficacy, teachers can break problems into smaller stages, demonstrate an initial strategy, create supportive groups, and emphasize the progress students have made. For students with high self-efficacy, teachers can provide more open-ended problems and encourage them to evaluate multiple alternative solutions. These strategies maintain an appropriate level of challenge while expanding opportunities for all students to develop numeracy skills.

This study was limited by its inclusion of only 10 participants from a single class and school, the absence of a control group, and the small self-efficacy subgroups. The pre-experimental design also limited control over other factors that may have been associated with changes in scores. The findings should therefore be generalized cautiously, and the reported effectiveness primarily reflects changes in the fifth-grade context at SD Negeri 13 Andoolo.

## CONCLUSION

The self-efficacy of fifth-grade students at SD Negeri 13 Andoolo was generally in the high category, although 4 of the 10 students remained in the low category. The implementation of Problem-Based Learning was effective in improving numeracy skills within the group studied, as demonstrated by an increase in the mean score from 49.8

at pretest to 79.2 at posttest, a moderate N-gain of 0.59, and a significant paired-test result. Posttest scores differed between the high- and low-self-efficacy groups, with students in the high category achieving a higher mean numeracy score. However, differences in initial ability and the small subgroup sizes limit the interpretation of this relationship. Teachers can use PBL to develop numeracy skills while continuing to provide gradual support, positive feedback, and levels of challenge appropriate to students' self-efficacy.

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