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Enhancing Fraction Learning Outcomes through Reflective Learning Activities in Elementary School

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ABSTRACT

This study investigated the effect of a reflective learning approach on elementary students' learning outcomes in fraction materials. The study was motivated by students' difficulties in understanding fractions conceptually due to conventional teacher-centered instruction. A quasi-experimental design with a nonequivalent control group design was employed involving 55 fourth-grade students divided into experimental and control groups. Data were collected through pretest-posttest learning outcome tests and student response questionnaires. The findings revealed a significant difference between students taught using the reflective learning approach and those taught conventionally, indicated by the independent sample t-test result (Sig. = 0.000 < 0.05). The experimental group achieved a higher posttest mean score (82.75) than the control group (72.14). Furthermore, the effect size analysis showed a high effect category (Cohen's d = 1.21). These findings indicate that reflective learning emphasizing students' learning experiences and conceptual understanding effectively improves fraction learning outcomes in elementary school mathematics. The study contributes to the development of student-centered mathematics instruction at the primary education level.

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INTRODUCTION

Mathematics learning plays an important role in developing students' logical, analytical, and problem-solving abilities needed in the 21st century. However, many elementary school students still experience difficulties in understanding mathematical concepts, particularly fractions. Fraction learning is often considered challenging because students tend to memorize procedures without fully understanding the meaning of fractions conceptually. As a result, students frequently encounter misconceptions when comparing fractions, interpreting numerators and denominators, and applying fractions in problem-solving situations. Research indicates that difficulties in fraction learning remain one of the major problems in elementary mathematics education worldwide (Ismail et al., 2024; Muhadi et al., 2025).

International assessments such as the Programme for International Student Assessment (PISA) indicate that Indonesian students' mathematical literacy remains below the OECD average, particularly in conceptual understanding and problem-solving skills (OECD, 2023). This condition suggests that mathematics instruction in schools still requires improvement, especially in creating meaningful learning experiences that help students actively construct conceptual understanding rather than relying solely on procedural instruction. Various studies have shown that students' mathematical achievement is strongly influenced by learning approaches that encourage active

participation, reflection, and contextual understanding (Cahyaningsih et al., 2025; Firdaus et al., 2024).

At the elementary school level, fraction topics require students to connect abstract mathematical representations with real-life situations. However, classroom instruction is still predominantly teacher-centered, where students passively receive information and practice routine exercises. Such instructional practices often limit students' opportunities to reflect on their learning experiences and develop deeper conceptual understanding. Consequently, students may achieve low learning outcomes and struggle to apply fraction concepts in different contexts. Recent studies also revealed that many students fail to retain fraction concepts because learning activities emphasize memorization instead of conceptual reasoning and experiential understanding (Khoerunnisa et al., 2026; Nurjanah, 2026).

One alternative to address this issue is the implementation of reflective learning activities. Reflective learning emphasizes students' active involvement in interpreting their learning experiences, connecting prior knowledge with new concepts, and constructing understanding through meaningful learning processes. Through reflective activities, students are encouraged to analyze their thinking processes, discuss ideas collaboratively, and relate mathematical concepts to real situations. This approach aligns with constructivist learning theory, which views knowledge as actively constructed through experience and reflection (van Manen, 2020). Reflective learning has also been reported to improve students' critical thinking, mathematical reasoning, and conceptual understanding in mathematics education (Syamsuddin et al., 2021; Siti, 2024).

Previous studies have demonstrated that student-centered learning approaches, such as Problem-Based Learning, Realistic Mathematics Education, experiential learning, and technology-assisted instruction, can improve students' mathematical understanding and learning outcomes. For example, contextual and realistic mathematics instruction has been shown to improve students' understanding of fractions and collaborative mathematical thinking (Muhadi et al., 2025). Furthermore, interactive digital learning media and reflective instructional models were found to positively influence elementary students' mathematics achievement and engagement (Ulfah & Malik, 2025). Other studies also reported that manipulative media and experiential activities help students visualize fraction concepts more concretely and meaningfully (Al Ayyubi et al., 2025).

Despite these findings, previous studies have mainly focused on contextual learning models, digital media integration, and problem-solving approaches. Limited studies have specifically examined the effectiveness of reflective learning activities in improving elementary students' fraction learning outcomes using quantitative experimental designs. In addition, research investigating how reflective learning supports students' conceptual understanding of fractions at the primary education level remains relatively limited. Therefore, this study attempts to fill this gap by investigating the effect of reflective learning activities on students' learning outcomes in fraction topics.

This study aims to analyze whether reflective learning activities significantly improve elementary students' learning outcomes in fraction materials compared to conventional instruction. The findings of this study are expected to contribute theoretically to the development of student-centered mathematics learning approaches and practically provide alternative instructional strategies for elementary school teachers in teaching fractions more meaningfully and effectively.

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RESEARCH METHOD

This study employed a quantitative approach using a quasi-experimental design with a nonequivalent control group design. The study aimed to examine the effect of reflective learning activities on students' learning outcomes in fraction materials. The experimental group received instruction through reflective learning activities, while the control group was taught using conventional instruction. Pretest and posttest were administered to measure students' learning outcomes before and after treatment.

The study was conducted at a public elementary school in North Sumatra, Indonesia, during the 2025/2026 academic year. The participants consisted of 55 fourth-grade students divided into an experimental class (28 students) and a control class (27 students). The sample was selected using purposive sampling based on similarities in students' prior mathematics achievement.

The treatment was conducted over eight meetings. In the experimental class, students participated in reflective learning activities such as discussing problem-solving strategies, relating fraction concepts to daily life, and writing short reflections about their learning experiences. Meanwhile, the control class received teacher-centered instruction focused on explanations and procedural exercises.

The research instruments consisted of a mathematics learning outcome test and a student response questionnaire. The learning outcome test covered fraction concepts, fraction operations, and contextual problem-solving. Instrument validity was evaluated through expert judgment, while reliability testing using Cronbach's Alpha showed a reliability coefficient of 0.82, indicating high reliability.

Data were analyzed using descriptive and inferential statistics with the assistance of IBM SPSS Statistics version 25. Descriptive statistics included mean scores and standard deviations. The normalized gain (N-Gain) analysis was used to determine students' learning improvement. Before hypothesis testing, normality and homogeneity tests were conducted using the Kolmogorov–Smirnov test and Levene's Test. The hypothesis was tested using an independent sample t-test at a significance level of 0.05. Cohen's d effect size analysis was also conducted to determine the practical significance of the treatment effect.

RESULTS AND DISCUSSION

RESULTS

The results of this study were obtained from the analysis of pretest and posttest scores in both the experimental and control groups. The analysis aimed to determine the effect of reflective learning activities on students' learning outcomes in fraction materials.

Table 1. Descriptive Statistics of Students' Learning Outcomes

Group	N	Pretest Mean	SD	Posttest Mean	SD
Experimental	28	56.43	8.12	82.75	6.45
Control	27	55.89	7.98	72.14	7.21

Table 1 shows that the pretest mean scores of both groups were relatively similar, indicating that students had comparable initial abilities before the treatment. After the implementation of reflective learning activities, the experimental group achieved a higher posttest mean score than

the control group. The experimental group improved by 26.32 points, while the control group improved by 16.25 points.

To measure students' learning improvement, the normalized gain (N-Gain) analysis was conducted.

Table 2. N-Gain Analysis of Students' Learning Outcomes

Group	N	Pretest Mean	SD	Posttest Mean	SD
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Table 2. N-Gain Analysis of Students' Learning Outcomes

Group	N-Gain	Category
Experimental	0.71	High
Control	0.42	Medium

The results indicate that the experimental group achieved a high level of improvement, whereas the control group showed only a moderate improvement. This finding suggests that reflective learning activities were more effective in improving students' understanding of fraction concepts.

Before hypothesis testing, prerequisite analyses were conducted. The results of the Kolmogorov–Smirnov normality test and Levene's homogeneity test showed significance values greater than 0.05, indicating that the data were normally distributed and homogeneous.

Table 3. Independent Sample t-Test Results

Variable	t-value	Sig. (2-tailed)	Decision
Learning Outcomes	4.672	0.000	H_o Rejected

The independent sample t-test results showed a significance value of 0.000 < 0.05. Therefore, the null hypothesis (H_o) was rejected, indicating a significant difference between the learning outcomes of students taught through reflective learning activities and those taught using conventional instruction.

Furthermore, the effect size analysis using Cohen's d produced a value of 1.21, which falls into the high category. This indicates that reflective learning activities had a strong practical effect on students' fraction learning outcomes.

Discussion

The findings of this study indicate that reflective learning activities significantly improved elementary students' learning outcomes in fraction materials. Students who participated in reflective learning achieved higher posttest scores and learning gains than those who received

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conventional instruction. These findings suggest that reflective learning activities can support students in developing a deeper conceptual understanding of fractions.

The improvement in students' learning outcomes may be attributed to the reflective learning process that encouraged students to connect mathematical concepts with their prior experiences and daily life situations. Through reflection, discussion, and collaborative problem-solving, students actively constructed their understanding rather than merely memorizing procedures. This finding supports constructivist learning theory, which emphasizes that knowledge is actively built through meaningful experiences and reflection (van Manen, 2020).

The results are also consistent with previous studies showing that student-centered and experiential learning approaches positively influence mathematics achievement. Muhadi et al. (2025) found that contextual mathematics learning improved elementary students' understanding of fractions by helping students relate abstract concepts to real situations. Similarly, Ulfah and Malik (2025) reported that interactive and reflective learning activities increased students' engagement and conceptual understanding in mathematics learning.

Research by Fatharani et al. (2024) demonstrated that student-centered instructional models such as Problem-Based Learning and Discovery Learning significantly improved students' mathematical connection abilities because students were encouraged to actively construct their understanding through exploration and discussion. This supports the findings of the present study, where reflective learning activities facilitated students in connecting fraction concepts with meaningful learning experiences.

Similarly, Triana et al. (2021) found that Discovery Learning and Problem-Based Learning positively influenced students' metacognitive abilities and mathematical connections. Reflective learning activities implemented in this study also promoted students' metacognitive awareness through self-reflection, collaborative discussion, and evaluation of problem-solving processes. These activities helped students develop deeper conceptual understanding rather than relying solely on memorization procedures.

In addition, Hafidzah et al. (2021) reported that the Open-Ended learning approach improved students' mathematical problem-solving abilities and learning independence because students were given opportunities to express various solution strategies. This aligns with the present study in which students actively reflected on their mathematical thinking and discussed multiple approaches to solving fraction problems. Such reflective processes likely contributed to the significant improvement in students' learning outcomes.

The effectiveness of active and reflective mathematics learning was further supported by Subagio et al. (2021), who found that Discovery Learning and Problem-Based Learning assisted by GeoGebra increased students' motivation and engagement in mathematics learning. In the present study, reflective learning activities also increased students' participation and confidence during classroom discussions, which positively influenced their conceptual understanding of fractions.

Moreover, reflective learning activities provided opportunities for students to express their ideas, evaluate their understanding, and discuss problem-solving strategies collaboratively. Such activities likely enhanced students' confidence and participation during learning. Previous studies also highlighted that reflective thinking supports higher-order thinking skills, particularly in interpreting mathematical situations, comparing strategies, and drawing conclusions logically (Putra & Hakim, 2023; Febrianty et al., 2024).

The high effect size obtained in this study indicates that reflective learning activities not only produced statistically significant results but also had substantial practical significance in improving students' mathematics learning outcomes. This finding demonstrates that reflective learning can serve as an effective alternative instructional strategy for teaching fraction materials at the elementary school level.

However, this study has several limitations. The study involved participants from only one school, limiting the generalizability of the findings. In addition, the duration of the treatment was relatively short. Previous studies suggested that reflective learning requires consistent and long-term implementation to optimally develop students' reflective thinking skills and conceptual understanding (Noer et al., 2024). Therefore, future studies are recommended to involve larger samples, longer implementation periods, and more diverse educational settings.

Overall, the findings of this study contribute to the development of student-centered mathematics instruction by providing empirical evidence that reflective learning activities effectively improve elementary students' understanding of fraction concepts and learning outcomes.

CONCLUSION

This study investigated the effect of reflective learning activities on elementary students' learning outcomes in fraction materials. The findings revealed a significant difference between students taught through reflective learning activities and those taught using conventional instruction. Students in the experimental group achieved higher posttest scores and learning gains, indicating that reflective learning activities effectively improved students' understanding of fraction concepts.

The results suggest that reflective learning encourages students to actively connect mathematical concepts with their learning experiences, engage in collaborative discussions, and develop deeper conceptual understanding. In addition, the high effect size indicates that reflective learning activities had a strong practical impact on students' mathematics learning outcomes.

This study contributes to the development of student-centered mathematics instruction, particularly in elementary fraction learning. Practically, reflective learning activities can be used as an alternative instructional strategy to create more meaningful and engaging mathematics learning experiences.

However, this study was limited to one school and a relatively short treatment duration. Therefore, future research is recommended to involve larger samples, longer implementation periods, and different mathematical topics to strengthen the generalizability of the findings.

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