



## The Effect of Discovery Learning on Fractions in Grade V

Iftitah<sup>1\*</sup>, Nursina Sari<sup>2</sup>, Haifaturrahman<sup>3</sup>,

<sup>1</sup>Universitas Muhammadiyah Mataram, Indonesia

<sup>2</sup>Universitas Muhammadiyah Mataram, Indonesia

<sup>3</sup>Universitas Muhammadiyah Mataram, Indonesia

[iftitahjumadin@gmail.com](mailto:iftitahjumadin@gmail.com)\*, [sarinursina1234@gmail.com](mailto:sarinursina1234@gmail.com), [haifaturrahmah@yahoo.com](mailto:haifaturrahmah@yahoo.com)

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### ABSTRACT

This study investigates the effect of the Discovery Learning method on elementary students' ability to represent fractions. The study was motivated by the persistent difficulty students face in expressing fractions in visual, symbolic, and verbal forms often due to the dominance of conventional teaching approaches. Instead of focusing on procedural instruction, Discovery Learning encourages students to actively construct knowledge, leading to deeper conceptual understanding. The findings reveal that students who learned through Discovery Learning demonstrated stronger mathematical representation skills compared to those taught using traditional methods. Beyond improving test performance, this approach fosters active engagement, problem-solving skills, and conceptual mastery of fractions. These results highlight the broader implication that discovery-based approaches can serve as an effective alternative to conventional teaching in mathematics education, particularly in addressing common challenges in fraction learning.



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## INTRODUCTION

(Song & Yu, 2025; Xu & Zhai, 2019) Mathematics is a fundamental discipline and plays a crucial role in developing logical, critical, and systematic thinking skills (Mukhlis, 2025a; Mukhlis & Saidah, 2025). In the context of basic education, mathematics serves as the primary foundation for mastering other sciences (Malikah et al., 2022). Through mathematics learning, students are expected to not only understand concepts and procedures but also be able to apply this knowledge in everyday life. One indicator of successful mathematics learning is students' ability to represent mathematical ideas in various forms that can be understood and used to solve problems.

Mathematical representation skills encompass students' ability to transform mathematical information or ideas into images, symbols, tables, graphs, or verbal explanations (Dichek et al., 2021; Nosofsky & Hu, 2022). This ability is crucial because through appropriate representation, students can understand relationships between concepts, clarify their thinking, and communicate solutions to problems (Mukhlis, Janwari, et al., 2023; Mukhlis & Abdullah, 2025). According to the National Council of Teachers of Mathematics (NCTM), representation is a standard process in mathematics learning that must be developed from an early age. Without effective representation, students' understanding of mathematical concepts will tend to be shallow and mechanistic.

One of the topics in mathematics that requires a strong mastery of representation is the concept of fractions. This material introduces students to the idea of parts of a whole, comparisons, and conversions between fractions (ordinary, decimal, percent). However, in practice, many elementary school students experience difficulty understanding and representing fractions (Ewald et al., 2022; Hoban, 2021). They tend to simply memorize symbols without understanding their conceptual meaning. For example, students can answer that  $\frac{1}{2} + \frac{1}{4} = \frac{3}{4}$  procedurally, but cannot visually explain what the addition means or how to represent fractions in pictorial form. This indicates that students' conceptual understanding and representation of fractions are still very low.

This problem is exacerbated by the continued dominance of conventional learning methods in the classroom. Lectures and exercises without contextualization lead to passive students who simply receive information without internalizing it (Mukhlis, Maryam, et al., 2023; Mukhlis et al., 2024). Students are not given the space to explore, ask questions, or discover the meaning of what they learn. In this type of learning, the teacher becomes the center of knowledge while students merely listen and memorize. As a result, students' critical thinking, problem-solving, and mathematical representation skills do not develop optimally.

In response to these issues, innovation is needed in learning approaches that are active, constructive, and oriented toward students' thinking processes. One relevant approach is the Discovery Learning method (Marletta, 2025; Muhtadi et al., 2022). Discovery Learning is a learning method that encourages students to discover knowledge for themselves through direct experience, observation, experimentation, and analysis. In this model, students are actively involved in the learning process, from identifying problems and formulating hypotheses to gathering information and drawing conclusions. Thus, Discovery Learning not only improves conceptual understanding but also trains logical thinking skills and the ability to represent knowledge in various forms.

This method is highly suitable for learning fraction concepts because it allows students to concretize abstract ideas into more tangible and understandable forms (Mukhlis, Arifin, Ridwan, & Zulbaidah, 2025; Mukhlis, Arifin, Ridwan, Zulbaidah, et al., 2025). For example, students can use concrete objects (paper, cookies, rulers) to represent fractions, then connect them with mathematical symbols and verbal explanations. This approach will strengthen students' understanding because it involves various cognitive and sensorimotor aspects. Furthermore, Discovery Learning is also in line with Piaget's constructivism theory, which emphasizes that students construct knowledge through active interaction with their environment.

Several previous studies have demonstrated the effectiveness of the Discovery Learning method in improving students' learning outcomes and representational abilities. (Luo et al., 2025) showed that visual-assisted Discovery Learning significantly improved students' understanding of fractions. Research by Abrori et al., (2024) also confirmed that a discovery-based approach can improve students' symbolic and visual representational abilities in mathematics. These findings reinforce the importance of further exploring the application of Discovery Learning in elementary school contexts.

Based on this background, this study aims to determine the effect of the Discovery Learning method on elementary school students' mathematical representation of fraction concepts (Mukhlis, 2025b; Mukhlis, Suradi, et al., 2023). This research is expected to make a real contribution to developing effective learning models and serve as a reference for teachers in designing learning strategies that can improve the quality of students' understanding and representation skills.

## **RESEARCH METHODS**

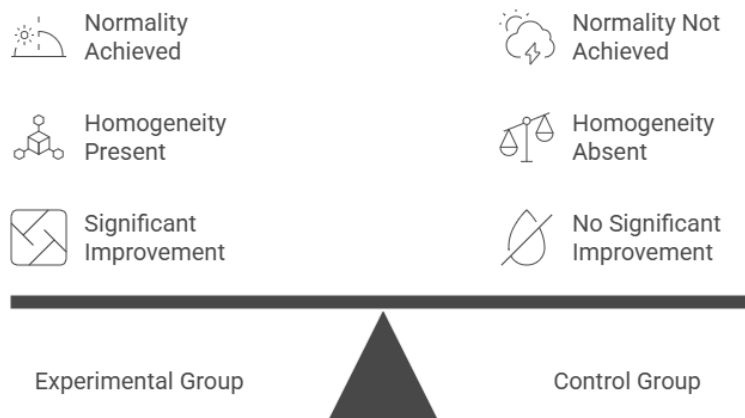
This study used a quantitative approach with a quasi-experimental design and a nonequivalent control group pretest-posttest design to determine the effect of the Discovery Learning method on elementary school students' mathematical representation of fractions (Clair, 2003; Fife, 2020; Kawamura, 2020). The study was conducted at SDN 20 Ampenan, Mataram City, in the even semester of the 2024/2025 academic year, with fifth-grade students consisting of two classes (Hillman & Radel, 2018; Lutz & Knox, 2014; McNabb, 2015): V A as the experimental group (24 students) and V B as the control group (23 students), selected purposively based on equal academic ability (Daly, 2007; Fenton & Baxter, 2016; Murphy & Dingwall, 2017). The experimental class implemented six stages of Discovery Learning, namely stimulation, problem identification, data collection and processing, proof, and conclusion drawing, while the control class used lecture and practice methods (Iosifides, 2016; Longhofer et al., 2012). The research instrument was a multiple-choice test of 20 questions, but only 14 valid questions were used after being tested on 30 students from other schools (Carreiras & Castro, 2012; Migdal, 2018). The test was given before and after the treatment (pretest and posttest), accompanied by observations of student activities and learning documentation. The data were analyzed using SPSS 29.0 through a normality test (Kolmogorov-

Smirnov), a homogeneity test (Levene's Test), and an independent t-test to determine the differences in the posttest results of the two groups with a significance limit of  $\alpha = 0.05$ .

**RESULTS AND DISCUSSION**

This study aims to determine the effect of the Discovery Learning method on elementary school students' mathematical representation skills in fractions. Data analysis was conducted through a series of statistical tests to determine differences in learning outcomes between the experimental and control groups. The following presents the results of normality, homogeneity, and t-test tests, complete with interpretations per table.

**Comparing Learning Outcomes in Fractions**



**1. Normality Test Results**

The normality test aimed to determine whether the pretest and posttest data for each group were normally distributed. The test was conducted using the Kolmogorov-Smirnov method with a significance level ( $\alpha$ ) of 0.05. The test results are presented in Table 1 below:

**Tabel 1. Hasil Uji Normalitas Data Pretest dan Posttest**

<b>Kelas</b>	<b>Jenis Tes</b>	<b>Sig. (p-value)</b>
Eksperimen	Pretest	0,200
Eksperimen	Posttest	0,143
Kontrol	Pretest	0,183
Kontrol	Posttest	0,116

Based on the results in Table 1, all sig. values are  $> 0.05$ . This means that all four types of data (pretest and posttest from both groups) are normally distributed, thus fulfilling the requirements for further parametric testing. For example, the sig. value for the posttest of the experimental class is 0.143, which means there is no significant difference between the data distribution and the normal distribution ( $H_0$  is accepted). This is important because the validity of the t-test as a parametric test depends on the normality of the data.

**2. Homogeneity Test Results**

A homogeneity test was conducted to determine whether the two groups had equal variances. This test used Levene's Test, and the results are shown in Table 2.

**Tabel 2. Hasil Uji Homogenitas Varians Posttest**

Variabel	Sig. (p-value)
Posttest Eksperimen & Kontrol	0,271

A significance value of  $0.271 > 0.05$  indicates that the variance of the data for both groups is homogeneous, meaning there is no significant difference in the distribution of posttest data between the experimental and control classes. This means that the two groups can be compared fairly because they have equal variance. This homogeneity test is important because one of the basic assumptions in the independent t-test is the equality of variance between groups.

### 3. Independent Sample T-Test Results

After the data met the assumptions of normality and homogeneity, an independent t-test was conducted to determine whether there was a significant difference between the posttest results of the experimental and control classes. The descriptive statistics are shown in Table 3 below:

**Tabel 3. Rata-rata Hasil Posttest Kelas Eksperimen dan Kontrol**

Kelompok	N	Rata-rata	SD
Eksperimen	24	84,12	6,83
Kontrol	23	76,43	7,21

Based on Table 3, it can be seen that the average posttest score for students in the experimental class was higher, at 84.12, compared to the 76.43 for the control class. This indicates a difference in learning outcomes between the two groups. Furthermore, the standard deviation (SD) for the experimental class was 6.83, slightly smaller than the 7.21 for the control class. This indicates that students' scores in the experimental class were more evenly distributed, or in other words, students in this group demonstrated more consistent performance.

To determine whether this difference was statistically significant, a t-test was conducted, the results of which are shown in Table 4.

**Tabel 4. Hasil Uji-t Independent**

Variabel	t hitung	Sig. (2-tailed)
Posttest	3,812	0,000

The t-test results show that the calculated t is 3.812 and the sig. value (2-tailed) is 0.000. Because the significance value is  $<0.05$ ,  $H_0$  is rejected and  $H_1$  is accepted, which means there is a significant difference between the post-test results of students in the experimental class and the control class. In other words, the application of the Discovery Learning method has a significant positive effect on improving students' mathematical representation abilities.

Statistical test results indicate that the implementation of the Discovery Learning method significantly improved elementary school students' mathematical representation skills in fractions. The difference in average scores between the experimental and control classes indicates that students engaged in active, discovery-based learning were superior in absorbing and meaningfully representing fraction concepts.

More specifically, students in the experimental class demonstrated a tendency to understand fractions not only as numbers or symbols, but also as parts of a whole that can be illustrated through various forms of representation. For example, during the lesson, students were encouraged to use concrete objects such as paper circles divided into equal parts to understand the meaning of fractions  $\frac{1}{2}$ ,  $\frac{1}{4}$ , and so on. This activity facilitated visual representation. Next, students discussed their observations and

related them to mathematical symbols (e.g., "if we divide a cake into four parts and take one part, then we write  $\frac{1}{4}$ "), which honed symbolic representation. Group discussions and class presentations also encouraged students to explain their thinking verbally, contributing to verbal representation.

In conventional learning used in the control class, the learning process tends to be one-way and procedural. The teacher explains the material on the board and provides examples of problems, then students are asked to copy and do exercises. This approach doesn't provide much space for students to construct concepts independently, explore the meaning of fractions, or express their ideas. As a result, although students may be able to solve problems mechanically, their ability to understand and represent the meaning of fractions comprehensively is limited. This is also reflected in the lower mean posttest scores and higher standard deviations in the control class.

In terms of student engagement, Discovery Learning provides opportunities for students to be actively involved, collaborative, and reflective. In the learning process, students learn not only from the teacher but also from peers, from direct experience, and through the process of experimenting and discovering for themselves. These activities create a fun and meaningful learning environment, thus motivating students to be more active in understanding mathematical concepts.

This finding is supported by research by Huang & Pei, (2024), which found that the Discovery Learning method can significantly improve students' mathematical representation skills, particularly in fractions. Furthermore, research by Hermita et al., (2023) also demonstrated that discovery-based learning strategies are effective in developing students' conceptual thinking and symbolic representation skills. Theoretically, this approach aligns with Piaget's constructivism theory, which emphasizes that knowledge cannot be transferred directly but must be constructed independently by students through concrete experiences and social interactions.

Practically, the results of this study provide important implications for elementary school teachers in designing learning strategies. Teachers are not only required to deliver material but also need to create learning conditions that allow students to construct their own understanding. Discovery Learning is an effective alternative because it provides space for students to think, ask questions, experiment, and draw conclusions, all of which support the development of mathematical representation skills. Furthermore, the use of concrete and contextual media can help students connect abstract concepts with the realities of everyday life, thereby improving the overall quality of learning. Therefore, mathematics learning, especially on complex material such as fractions, will be more effective when implemented with an interactive, participatory, and student-centered approach, as facilitated by the Discovery Learning method.

## CONCLUSION

Based on the results of the analysis, this study concludes that the Discovery Learning method positively influences elementary school students' mathematical representation abilities in fractions. Students taught through Discovery Learning showed greater ability to represent fraction concepts in visual, symbolic, and verbal forms compared to those taught conventionally. This indicates that discovery-based approaches can support deeper conceptual understanding and foster critical as well as reflective thinking in mathematics learning. Nevertheless, this study has certain limitations. It was conducted in a single school with a limited number of participants, which may affect the generalizability of the findings. In addition, the study focused only on fractions as the mathematical topic, so the results may not directly extend to other mathematical domains. Future research is recommended to involve a larger and more diverse sample across different schools and contexts, as well as to explore the effectiveness of Discovery Learning in other mathematical topics or subject areas. Longitudinal studies could also provide insights into the sustainability of its impact on students' learning outcomes.

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