

## THE EFFECT OF THE GUIDED DISCOVERY LEARNING MODEL ON STUDENTS' MATHEMATICAL REASONING ABILITY

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**ABSTRACT** This quasi-experimental study aimed to investigate the effect of the Guided Discovery Learning (GDL) model on the mathematical reasoning ability of eighth-grade students. The population consisted of 319 students from Grade VIII at SMP Negeri 20 Bandar Lampung during the 2024/2025 academic year, distributed across ten classes (VIII-A to VIII-J). Using a purposive sampling technique, two classes were selected as research samples: class VIII-B (32 students) as the experimental group, which received instruction using the GDL model, and class VIII-A (32 students) as the control group, which received conventional cooperative learning. The study employed a pretest-posttest control group design. The research data were quantitative, obtained through a mathematical reasoning ability test on the topic of Systems of Linear Equations in Two Variables, administered before and after the intervention in both groups. Statistical analysis using an independent samples t-test on the gain scores revealed a statistically significant difference. The findings showed that students in the GDL group experienced greater improvement in mathematical reasoning ability compared to those in the control group. These results suggest that the GDL model has a positive and significant effect on enhancing students' mathematical reasoning skills.

**Keywords:** mathematical reasoning, guided discovery learning, cooperative learning, experimental research

**ABSTRAK** Penelitian kuasi-eksperimental ini bertujuan untuk mengkaji pengaruh model Guided Discovery Learning (GDL) terhadap kemampuan penalaran matematis siswa kelas VIII. Populasi penelitian terdiri dari 319 siswa kelas VIII di SMP Negeri 20 Bandar Lampung tahun ajaran 2024/2025 yang tersebar dalam sepuluh kelas (VIII-A hingga VIII-J). Sampel penelitian dipilih menggunakan teknik purposive sampling, yaitu kelas VIII-B (32 siswa) sebagai kelompok eksperimen yang dibelajarkan dengan model GDL, dan kelas VIII-A (32 siswa) sebagai kelompok kontrol yang menerima pembelajaran kooperatif konvensional. Penelitian ini menggunakan desain pretest-posttest control group. Data yang dikumpulkan berupa data kuantitatif dari tes kemampuan penalaran matematis pada materi Sistem Persamaan Linear Dua Variabel (SPLDV) yang diberikan sebelum dan sesudah perlakuan. Hasil analisis statistik menggunakan uji-t independent terhadap skor gain menunjukkan perbedaan yang signifikan secara statistik. Siswa yang mengikuti pembelajaran dengan model GDL mengalami peningkatan kemampuan penalaran matematis yang lebih tinggi dibandingkan siswa yang belajar dengan model kooperatif. Temuan ini mengindikasikan

bahwa model GDL memiliki pengaruh positif dan signifikan dalam meningkatkan kemampuan penalaran matematis siswa.

**Kata-kata kunci:** penalaran matematis, guided discovery learning, pembelajaran kooperatif, penelitian eksperimen

## INTRODUCTION

Mathematics is a fundamental subject in schools. As stated in the Regulation of the Minister of Education, Culture, Research, and Technology Number 12 of 2024 concerning the Curriculum for Early Childhood, Primary, and Secondary Education Levels, mathematics learning enables students to develop systematic, rational, and strong reasoning skills that serve as a foundation for functional thinking in real-life situations (Jusniati et al., 2024). One of the primary goals of mathematics education is to foster students' reasoning abilities. According to Kotto et al. (2022), mathematical reasoning is essential in mathematics learning because it equips students with the ability to solve problems, gather evidence, and draw logical conclusions. Hidayatullah et al. (2019) similarly emphasize that reasoning skills are indispensable in learning mathematics. However, in practice, students' mathematical reasoning abilities remain relatively low.

This concern is reflected in the results of the PISA 2022 assessment published by the OECD (2023), which revealed that Indonesia scored 366 in mathematics—well below the OECD average of 472. Compared to the PISA 2018 score of 379 (with an OECD average of 487), the 2022 results show a decline in performance. The PISA 2022 computer-based mathematics assessment categorizes mathematical thinking into four subscales: formulating, employing, interpreting, and reasoning. Indonesia's respective scores in these areas were 362, 365, 363, and 354, with reasoning receiving the lowest score. This indicates that Indonesian students' mathematical reasoning abilities are still underdeveloped.

A similar situation was observed in one of the public junior high schools in Bandar Lampung, based on students' responses to preliminary questions on the topic of Two-Variable Linear Equation Systems (SPLDV) and interviews with partner teachers. The interviews revealed that classroom learning was still dominated by teachers, resulting in limited student activity in exploring information and analyzing problems. This finding aligns with Rhofiqah (2019), who noted that students struggle with problem-solving tasks that require practical skills due to the continued use of teacher-centered learning models.

Considering the importance of mathematical reasoning, it is crucial to implement appropriate and effective instructional strategies to enhance this skill. An instructional approach that actively engages students and encourages them to apply their reasoning is needed. Farida et al. (2018) argue that improving students' reasoning abilities requires student-centered learning that offers opportunities for learners to express and justify their ideas.

One such student-centered model is Guided Discovery Learning (GDL). According to Lestari (2017), Nofiana (2020), Batubara (2020), Afifah (2021), and Nur et al. (2023), GDL involves structured guidance from teachers to help students discover concepts, principles, or relationships between ideas. In this model, the teacher functions as a facilitator or mentor who guides students through the problem-solving or discovery process. Kusuma et al. (2023) highlight that GDL promotes student engagement, supports reasoning development, and encourages interaction among students and between students and teachers. In this model, teacher guidance is intended to stimulate students' thinking and reasoning processes. As facilitators, teachers must actively direct students toward knowledge acquisition while ensuring students remain active in the discovery process (Hastuti, 2022). The reasoning developed through discovery is expected to benefit not only classroom learning but also daily life applications (Kusuma et al., 2023).

The nature of GDL demands that students take an active role in constructing their own understanding. Practically, students are grouped to collaborate with peers in solving problems and discovering concepts. They engage in discussions, exchange arguments, evaluate and accept or reject peer ideas, formulate hypotheses, and make group decisions. This type of learning process fosters the development of mathematical reasoning skills (Ario, 2017; Rahman & Maya, 2017).

In light of the aforementioned issues and theoretical considerations, there is a clear need to explore instructional models that can effectively enhance students' mathematical reasoning abilities. Guided Discovery Learning (GDL), with its emphasis on active student engagement and teacher-facilitated discovery, offers promising potential in this regard. Therefore, this study seeks to investigate the effect of the Guided Discovery Learning model on the mathematical reasoning abilities of junior high school students.

## **METHODS**

This study involved the entire population of eighth-grade students at a public junior high school in Bandar Lampung, totaling 319 students distributed across ten classes (VIII-A to VIII-J). The sampling technique used was purposive sampling, wherein participants are selected based on specific criteria determined by the researcher's judgment (Sudjana, 2005). The primary criteria for sample selection were that the classes were taught by the same mathematics teacher and exhibited relatively similar average scores on the most recent Unified Assessment. Based on these considerations, class VIII-A was assigned as the control group, while class VIII-B served as the experimental group.

The data collection technique employed in this research was testing, using a descriptive test instrument developed to assess students' mathematical reasoning abilities. The research design adopted was a pretest-posttest control group design. To examine the research hypothesis, a parametric statistical test was conducted

using an independent samples t-test to compare the mean gain scores between the two groups. The hypotheses were formulated as follows:

**H<sub>0</sub>:**  $\mu_1 = \mu_2$  (The average gain in mathematical reasoning ability of students taught using the Guided Discovery Learning model is equal to that of students taught using the Cooperative Learning model).

**H<sub>1</sub>:**  $\mu_1 > \mu_2$  (The average gain in mathematical reasoning ability of students taught using the Guided Discovery Learning model is greater than that of students taught using the Cooperative Learning model).

Before conducting the hypothesis testing, prerequisite tests were performed to ensure that the data met the assumptions of normality (using the Chi-Square test) and homogeneity (using the F-test). To quantify the degree of improvement in mathematical reasoning abilities, the normalized gain (N-Gain) was calculated based on the formula proposed by Hake (Wahab et al., 2021):

$$\text{N-Gain} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Ideal score} - \text{Pretest score}}$$

## FINDING AND DISCUSSION

The initial phase of data collection involved pretests in the experimental and control classes to ascertain students' mathematical reasoning baselines. These data are shown in Table 1.

**Table 1.** Data on Students' Initial Mathematical Reasoning Abilities

Class	Number of Students	Average	Lowest Score	Highest Score	Standard Deviation
Experiment	32	8,16	2	16	3,68
Control	32	9,47	4	29	5,68

An examination of Table 1 reveals that the control class demonstrated a higher average initial mathematical reasoning ability (with a difference of 1.31) in comparison to the experimental class. Furthermore, the control class presented both a higher minimum and a higher maximum score.

The final mathematical reasoning abilities of students in both the experimental and control classes were assessed using posttests. The resulting data are summarized in Table 2.

**Table 2.** Data on Students' Final Mathematical Reasoning Abilities

Class	Number of Students	Average	Lowest Score	Highest Score	Standard Deviation
Experiment	32	36.28	18	48	8.44
Control	32	26.00	10	45	9.04

The data presented in Table 2 indicate that the experimental class achieved a higher average final mathematical reasoning score than the control class, with a difference of 10.28 points. Additionally, the experimental class showed higher minimum and maximum scores.

Gain data, calculated based on pretest and posttest results, were used to assess the improvement of students' mathematical reasoning abilities following the Guided Discovery Learning (GDL) model and the Conventional Learning (CL) model. Based on the data collected in both classes, the gain scores are presented in Table 3.

**Table 3.** Gain in Students' Mathematical Reasoning Abilities

Class	Number of Students	Average Gain	Lowest Gain	Highest Gain	Standard Deviation
Experiment	32	0.71	0.25	1.00	0.21
Control	32	0.43	0.30	0.89	0.22

The data in Table 3 indicate that the experimental class achieved a greater average gain in mathematical reasoning ability compared to the control class.

Normality testing of the gain scores using the Chi-Square test showed that the experimental class ( $\chi^2_{\text{calculated}} = 5.55 < \chi^2_{\text{table}} = 11.07$ ) and the control class ( $\chi^2_{\text{calculated}} = 5.24 < \chi^2_{\text{table}} = 11.07$ ) had data drawn from normally distributed populations. A homogeneity test yielded  $F_{\text{calculated}} = 1.25 < F_{\text{table}} = 2.05$ , indicating that the variance between the two populations was homogeneous. Given the fulfillment of the normality and homogeneity assumptions, an Independent Samples T-Test was conducted. The results are shown in Table 4.

**Table 4.** Results of the Independent Samples T-Test on Gain in Mathematical Reasoning Abilities

Learning Model	N	Mean Gain	Variance	$t_{\text{calculated}}$	$\alpha$	$t_{\text{table}}$	Test Result
GDL	32	0.71	0.04	5.00	0.05	1.67	Reject $H_0$
CL	32	0.43	0.05				

Table 4 shows that at a significance level of  $\alpha = 5\%$ , the t-value (5.00) exceeded the critical t-value (1.67), leading to the rejection of  $H_0$ . This result indicates that students taught using the GDL model had a statistically significantly higher average gain in mathematical reasoning abilities than those taught using the CL model.

Data on the achievement of mathematical reasoning indicators and the percentage of each student's achievement for each item in the experimental and control classes are presented in Table 5.

**Table 5.** Achievement of Mathematical Reasoning Indicators

No.	Mathematical Reasoning Indicator	GDL (%)		CL (%)	
		Initial	Final	Initial	Final
1.	Formulating conjectures	20,90	65,63	30,86	65,04
2.	Performing mathematical manipulation in problem-solving	11,52	58,40	14,26	36,52
3.	Constructing justification for the correctness of a solution	8,79	57,42	8,40	29,88
4.	Drawing conclusions	9,77	45,31	5,66	31,64

Table 5 demonstrates increases in all indicators. For formulating conjectures, the GDL class improved by 44.73%, while the CL class improved by 34.18%, resulting in a 10.55% advantage for GDL. For mathematical manipulation, the GDL class improved by 46.88%, compared to 22.27% in the CL class, a difference of 24.61%. In constructing justification, the GDL class improved by 48.63%, while the CL class improved by 21.48%, a difference of 27.15%. The ability to draw conclusions improved by 35.55% in the GDL class compared to 25.98% in the CL class, representing a 9.57% advantage.

The hypothesis testing demonstrated that the GDL model had a greater positive effect on students' mathematical reasoning abilities than the CL model. This is evident from the higher average gain score achieved by students in the GDL class. These findings are consistent with those of Kusuma et al. (2023) and Nurhalizah & Siregar (2024), who also reported the effectiveness of the GDL model in enhancing mathematical reasoning abilities.

The observed improvement in students' mathematical reasoning abilities using the GDL model can be attributed to the distinct stages of instruction in GDL. These stages—stimulation, problem statement, data collection, data processing, verification, and generalization—actively engage students and promote deeper learning. This structured approach encourages students to investigate concepts, analyze information critically, and construct their own understanding.

According to Fadli & Mirna (2019), students are stimulated through problem statements, arousing curiosity and prompting them to make conjectures. In the data collection stage, students gather relevant information, which they then process in the next stage to determine solutions. These solutions are verified in the subsequent stage to assess their accuracy, followed by generalization to draw broader conclusions.

The development of conjecturing and manipulation skills results from the stimulation and problem statement stages. Fadli & Mirna (2019) emphasize that students can formulate conjectures when stimulated by contextual problems,

especially when the teacher poses guiding questions relevant to daily life. In the problem identification stage, students examine multiple relevant issues using the student worksheet to help formulate hypotheses and initiate problem-solving.

The development of justification skills is supported by the data collection and data processing stages. During data collection, students actively seek information relevant to the problem. In the processing stage, they analyze this information, perform necessary calculations, and discuss solutions in groups. When difficulties arise, students return to earlier data or consult the teacher for support.

The ability to draw conclusions emerges in the verification and generalization stages. In verification, students assess whether their hypotheses align with the results obtained during processing. Most students complete this collaboratively through group discussions. In the generalization stage, students synthesize all prior steps to formulate final conclusions. Representatives then present their group's findings and conclusions based on the session's material. This process aligns with the explanation of Fadli & Mirna (2019).

In implementing GDL, several challenges arose. Some students were unfamiliar with the contextual problems in the student worksheet, requiring teacher support for comprehension. During the first session, many students ignored the instructions and immediately filled in the answer boxes. The teacher had to guide them to read instructions thoroughly. This reflects Fadli & Mirna's (2019) observation that students initially struggled with using the worksheet but improved with teacher guidance in subsequent sessions.

Another challenge was classroom conduciveness. During the initial meeting, students were still adapting to the stages of GDL, which required significant time. The teacher played an important role in maintaining a conducive learning environment. As Rosmisi (2020) noted, in the GDL model, the teacher actively manages and supports students rather than leaving them to work independently without direction.

Over five meetings, the implementation of GDL contributed to notable improvements in students' reasoning abilities. Maula (2019) states that GDL promotes student activity, perseverance, creativity, and problem-solving processes, leading to deeper understanding and long-term retention. Similarly, Batubara (2020) argues that students construct knowledge more effectively when engaged in active learning. Nofiana (2020) supports this by stating that GDL facilitates the development of cognitive processes, self-directed learning, and meaningful learning experiences. Such improvements are less likely in the CL model, which relies on teacher-led instruction and limits opportunities for exploration. Students mainly receive direct explanations from the teacher, reducing engagement and meaningful learning opportunities.

## CONCLUSIONS AND RECOMMENDATIONS

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Based on the findings and discussion, this study concludes that the Guided Discovery Learning (GDL) model significantly enhances students' mathematical reasoning abilities compared to the Conventional Learning (CL) model. The structured phases of GDL—stimulation, problem statement, data collection, data processing, verification, and generalization—create opportunities for active learning, critical thinking, and student autonomy, contributing to deeper conceptual understanding. The statistical evidence from pretest-posttest comparisons and gain analysis supports the effectiveness of the GDL model in fostering mathematical reasoning skills. Accordingly, the GDL model can be considered a valuable pedagogical approach and is recommended for integration into mathematics instruction, particularly at the junior secondary level. Its application may help learners construct knowledge more meaningfully and retain mathematical concepts over time. However, effective implementation requires careful attention to certain aspects of the learning process. For instance, the stimulation phase should be emphasized, as many students may initially struggle with contextual problems or unfamiliar formats in student worksheets. Teachers must be prepared to guide learners through this transition to ensure engagement and comprehension. For practitioners and researchers interested in adopting or further investigating the GDL model, it is important to consider not only the general outcomes but also the specific instructional components and criteria for measuring learning effectiveness. Future research could explore how different student characteristics or classroom contexts influence the success of GDL, providing a more nuanced understanding of its impact. Overall, the GDL model offers promising potential for enhancing mathematical reasoning and cultivating independent learners.

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