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Students' Mathematical Reflective Thinking Ability with Guided Discovery Learning on Pythagorean Theorem Material

Kysa Windia Rosa, Nurhanurawati*, Nurain Suryadinata
Pendidikan Matematika, Universitas Lampung, Indonesia
*Correspondence E-mail: nurhanurawati94@gmail.com

Abstract

This study aims to determine the effect of the guided discovery learning model on students' mathematical reflective thinking ability. The population in this study were all 8th grade students in one of the schools in Lampung in the 2024/2025 academic year as many as 287 students distributed into 9 classes. The sample in this study took two classes totaling 29 and 27 students respectively which were selected using a cluster random sampling technique. The design used was posttest only control group design. The data collection technique used was a test technique with an instrument in the form of a 4-item mathematical reflective thinking ability test question sheet. Based on the results of the normality test and homogeneity test, it was found that the posttest data from the two groups were normally distributed and homogeneous. Furthermore, the hypothesis test using the independent sample t-test test showed that the mathematical reflective thinking ability of students who followed the guided discovery learning model was higher than the mathematical reflective thinking ability of students who followed the direct instruction model. Therefore, it can be concluded that the guided discovery learning model affects students' mathematical reflective thinking ability.

Keywords: *Effect, Guided discovery learning, Mathematical reflective thinking ability*

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INTRODUCTION

Mathematics is one of the basic subjects that has a crucial role in shaping systematic, logical, and critical thinking in students. The important role of mathematics is not only limited to the academic context, but also in everyday life that requires abstract, analytical, and reflective thinking ability (Marfu et al., 2022; Riswadi & Adirakasiwi, 2023). Mathematics is also considered key in supporting technological and scientific advances, as well as a thinking tool to solve problems in various fields of life (Aminah & Rohayati, 2021; Anwar & Sofiyan, 2018).

Along with the development of a curriculum that prioritizes higher order thinking ability, mathematics learning in schools is expected not only to be oriented towards the ability to memorize formulas, but also to train students to be able to think reflectively in understanding and solving problems (Isnurani, 2018; Fatra et al., 2022). Reflective thinking ability reflects the quality of mature thinking, which involves metacognitive processes, such as evaluating information, connecting existing knowledge with new information, and making the right decision based on critical analysis (Ramadhani & Aini, 2019; Andrean et al., 2019).

The results of the 2022 PISA (Programme for International Student Assessment) survey released by the OECD (Organization for Economic Co-operation and Development) show that Indonesian students' mathematics scores have decreased significantly, from 379 points in 2018 to 366 points in 2022. This score is far below the average of OECD countries which reached 488 points (OECD, 2023). This decline indicates students' weak ability to understand, analyze, and solve mathematical problems reflectively. PISA questions not only measure memorization, but also demand reflective thinking ability that involve interpreting information, evaluating complex situations, and making data-based decisions (Kartikasari & Kurniasari, 2020; Juhaevah, 2017).

Previous research also confirms a similar phenomenon. Studies conducted by Junaedi et al. (2019), Sihaloho & Zulkarnaen (2019), and Kurniasari & Fauziah (2019) showed that junior high school students still have difficulties in identifying the core of the problem, connecting concepts that have been learned with new situations, and drawing conclusions from the problem solving process. Similar conditions were also found in a preliminary study at one of the junior high schools in Lampung. Based on the results of the reflective thinking ability test given to class IX students, it was found that 24 out of 31 students were not able to answer contextual problem-based questions correctly. A total of 24 students showed errors in identifying important information and in developing a solution strategy, and were unable to conclude their findings logically. This indicates that students' mathematical reflective thinking ability are still low.

This condition indicates that mathematics learning still tends to focus on procedural mastery and is not optimal in fostering students' reflective thinking processes (Ningrum & Fauziah, 2021; Ashari et al., 2024). The dominant learning model used is a conventional one-way model, where the teacher is the center of information and students are passive as recipients (Helmiati, 2016; Bari, 2015). In fact, according to Rachmat et al. (2020), one of the important factors in improving reflective thinking ability is a learning model that can facilitate students to actively think, ask questions, investigate, and draw conclusions independently.

One of the potential models used is the Guided Discovery Learning model. This model allows students to discover mathematical concepts by themselves through a series of explorative activities guided by the teacher (Ariyana et al., 2018; Noer, 2018). This model encourages students to actively participate in the learning process by going through stages such as stimulation, problem identification, data collection, data processing, verification, and conclusion drawing (Sari & Noer, 2015; Adelia et al., 2019). Therefore, learning is not only teacher-centered, but students are trained to use logic, experience, and knowledge to form a complete and in-depth understanding.

Previous research has shown that Guided Discovery Learning is effective in improving students' reflective thinking ability (Pradana et al., 2024; Hanafi, 2019; Winangun et al., 2021). Students who learn using this model show higher active participation, the ability to explain solutions more logically, and a tendency to evaluate their own thinking processes more deeply (Susanti & Pratiwi, 2022). This model is also proven to develop reflective thinking indicators such as reacting, comparing, and contemplating (Aini & Kurniasari, 2021; Noviyanti et al., 2021).

However, the implementation of this model has not been studied in depth in the context of mathematics learning at the junior high school level, especially in relation to reflective thinking ability. Therefore, this study was conducted to examine the effect of Guided Discovery Learning model on students' mathematical reflective thinking ability. It is hoped that the results of this study can make theoretical and practical contributions in efforts to improve the quality of mathematics learning, and become the basis for developing learning strategies that are more effective in building students' reflective thinking ability.

Based on the description above, the hypotheses in this study are:

1. General Hypothesis:
   Guided Discovery Learning model affects students' mathematical reflective thinking ability.
2. Specific Hypothesis
   The average mathematical reflective thinking ability of students who follow the guided discovery learning model is higher than the average mathematical reflective thinking ability of students who follow the direct instruction model.

METHOD

This research is a quasi-experiment research with posttest only control group design. The study population was VIII grade students in one of the junior high schools in Lampung in the 2024/2025 school year. From nine classes, two classes were selected as samples through random sampling technique. One of the classes was used as an experimental class that received learning with a guided discovery learning model and the other class as a control class with a direct instruction model. Both classes were taught by the same teacher to minimize external variables.

The data collection technique used was a test technique with a test instrument in the form of a test question sheet that measured students' mathematical reflective thinking ability. The data obtained in the form of test scores of students' mathematical reflective thinking ability obtained through the final test (posttest). The test instrument is in the form of a description question that has gone through a content validation process by teaching practitioners. The test instrument was also tested to measure reliability ($\alpha = 0.70$), differentiating power (sufficient category), and difficulty level (medium category). The lattice of test instruments used in this study can be seen in Table 1.

Table 1. Instrument lattice

Aspect	Indicator	Question Number
Reacting	Mentioning known and questionable information from the problem presented	1,2,3,4
Comparing	Present solutions and compare information or mathematical objects based on Pythagorean concepts	1,2,3,4
Contemplating	Assess and prove the truth of a statement and draw conclusions based on mathematical concepts	1,2,3,4

Data were analyzed using parametric statistics. Previously, prerequisite tests were carried out, namely normality test and homogeneity test. Normality test was conducted with Liliefors test and homogeneity test with F test. If the data comes from a normally distributed population and has a homogeneous variance, the hypothesis test uses an independent sample t-test. The test hypotheses in this study are:

$H_0: \mu_1 = \mu_2$ (the average mathematical reflective thinking ability of students who follow the guided discovery learning model is the same as the average mathematical reflective thinking ability of students who follow conventional learning)

$H_0: \mu_1 > \mu_2$ (the average mathematical reflective thinking ability of students who follow the guided discovery learning model is higher than the average mathematical reflective thinking ability of students who follow conventional learning)

RESULTS AND DISCUSSION

Pretest Score Data of Students' Mathematical Reflective Thinking Ability

Pretest score data was obtained from experimental and control classes at the beginning of the meeting before treatment. Based on data analysis, descriptive data of mathematical reflective thinking ability of experimental and control class students were obtained, presented in Table 2.

Table 2. Pretest score data of students' mathematical reflective thinking ability

Class	Students	Mean	Lowest Score	Highest Score	Standard Deviation
Experiment	29	2,34	0	4	1,34
Control	27	1,7	0	6	1,98

Maximum Score: 36

Table 2. shows that the average pretest score of students' mathematical reflective thinking ability is different between the experimental and control classes. The lowest score for the experimental class is the same as the control class, but the highest score is greater for the control class than the experimental class. In addition, the standard deviation of the control class is also greater than the experimental class.

Posttest Score Data of Students' Mathematical Reflective Thinking Ability

Posttest score data were obtained from experimental and control classes at the end of the meeting after treatment. Based on data analysis, descriptive data of mathematical reflective thinking ability of experimental and control class students were obtained, presented in Table 3.

Table 3. Posttest score data of students' mathematical reflective thinking ability

Class	Students	Mean	Lowest Score	Highest Score	Standard Deviation
Experiment	29	27,586	19	36	4,10
Control	27	18,59	10	25	4,29

Maximum Score: 36

Table 3. shows that the average posttest score of students' mathematical reflective thinking ability is different between the experimental and control classes, with a difference of 8,99 greater for the experimental class. The lowest score and the highest score for the experimental class are much greater than the control class. But the standard deviation for the

control class is greater than that of the experimental class, indicating that the distribution of posttest scores in the control class is more diverse.

Hypotesis Test Result of Pretest Score Data of Students' Mathematical Reflective Thinking Ability

After going through the prerequisite test, namely the normality test, it was found that the pretest score data in the experimental class came from a normally distributed population. While in the control class, the data did not come from a normally distributed population. Therefore, data analysis uses a non-parametric test in the form of Mann Whitney-U. The results of the analysis are presented in Table 4.

Table 4. Hypothesis test results of pretest score data

Characteristics	Results	Test Decision
Z_{count}	1,639	H_0 accepted
Z_{table}	1,645	

The average pretest score of mathematical reflective thinking ability of experimental class students was 2,34, while the control class was 1,70. The Mann-Whitney U test results showed that there was no significant difference between the two classes before treatment $Z_{count}(1{,}639) < Z_{table}(1{,}645)$, so it can be concluded that the two classes have equal initial abilities.

Research Hypothesis Test Results

The results of the previous pretest hypothesis test data were that there was no significant difference between the two classes, so the research hypothesis analysis was carried out using the posttest score data of students' mathematical reflective thinking ability. Based on the results of the prerequisite test, it was obtained that the posttest score data of the mathematical reflective thinking ability of experimental and control class students came from a normally distributed population and both data had the same variance, so the two mean equality test used t-test statistics. The results of the hypothesis test of the posttest score data of students' mathematical reflective thinking ability are presented in Table 5.

Table 5. Results of data hypothesis test (t-test)

Characteristics	Results	Test Decision
t_{count}	8,01	H_0 rejected
t_{table}	1,67	

The results of data analysis showed that at a significance of $\alpha = 0{,}05$, the value of $t_{count}(8{,}01) > t_{table}(1{,}67)$ was obtained, then H_0 was rejected. Based on these results, it can be concluded that the average mathematical reflective thinking ability of students who follow the guided discovery learning model is higher than the average mathematical reflective thinking ability of students who follow the direct instruction model.

Discussion

Based on the results of data analysis and hypothesis testing, this study shows that the guided discovery learning model affects students' mathematical reflective thinking ability compared to the direct instruction model. This is in line with the results of research by Adelia et al., (2019) and Pradana et al., (2024) which state that the guided discovery learning model is effective in developing students' mathematical reflective thinking ability.

This is also supported by the achievement of indicators of students' mathematical reflective thinking ability, where the average achievement of indicators of students using guided discovery learning model reaches a higher percentage compared to students using direct instruction model. This proves that the application of guided discovery learning model can improve students' ability to identify problems, choose alternative solutions or solution strategies, analyze and evaluate problems and conclude the best solution compared to direct instruction model. The achievement of indicators of students' mathematical reflective thinking ability is presented in Table 6.

Table 6. Percentage of achievement of students' mathematical reflective thinking ability

Indicator	Class	
	Experiment	Control
Reacting	89,66%	46,91%
Comparing	86,20%	84,57%
Contemplating	54,02%	23,46%
Mean	76,62%	51,64%

The reacting indicator refers to the ability of students to respond to problems or information quickly and accurately. In the experimental class, the achievement of this indicator reached 89,66%, far above the control class which was only 46,91%. This difference shows that providing a stimulus in the form of contextual problems in the guided discovery learning model is effective in generating students' initial involvement.

In the learning process, the teacher provides illustrations of real situations that trigger students' curiosity and encourage them to associate prior knowledge with the context of the problem. The active responses shown by students are evidence that this strategy is successful in fostering the initial ability of reflective thinking. This is in line with the research of Yuliani and Saragih (2015), as well as Astuti et al., (2020), which confirms that the provision of contextual problems can increase initial engagement and encourage the emergence of reflective thinking from the early stages of learning.

The comparing indicator describes the ability of students to compare various approaches, solutions, or information obtained. The analysis showed that the experimental class students achieved 86,20%, slightly higher than the control class of 84,57%. Although the difference between classes was not significant, the guided discovery learning model still provided benefits through group discussion activities, exploration of ideas, and peer validation. These activities strengthen students' reflective process in assessing the effectiveness of different solution methods. Marlina and Budayasa (2020) stated that active involvement in group discussions can enrich the reflective thinking process, especially in the aspects of comparing and assessing alternative solutions.

The contemplating indicator reflects the ability of students to reflect and evaluate the process and results of their thinking in depth. The achievement of this indicator is still relatively low, namely 54,02% in the experimental class and 23.46% in the control class. This shows that most students are not accustomed to doing deep reflection on the thinking process they have done. Although the guided discovery learning model provides space for inference and open discussion, these ability require more structured practice and habituation. According to Sari and Widodo (2023), the contemplating aspect can only develop optimally if students are consistently trained to evaluate their thinking processes, including errors and strategies used.

Judging from the overall achievement of indicators of students' mathematical reflective thinking ability, classes with guided discovery learning models have higher achievements than direct instruction models.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the guided discovery learning model has an effect on the mathematical reflective thinking ability of class VIII students of SMPN 1 Liwa even semester of the 2024/2025 academic year. This is based on the research results which show that the mathematical reflective thinking ability of students who follow the guided discovery learning model is higher than the mathematical reflective thinking ability of students who follow the direct instruction model.

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BIOGRAPHIES OF AUTHORS

Kysa Windia Rosa is a student of the mathematics education study program at the University of Lampung. I am currently in my 8th semester and have a keen interest in education. During college I actively participated in student organization activities. Can be contacted via email: windiarosakysa@gmail.com

Dr. Nurhanurawati, M.Pd., is a lecturer in Mathematics Education at Lampung University. She completed his Bachelor (S1) education from Lampung University, Master (S2) and Doctoral (S3) from Malang State University. She is involved in various studies, including research on divergent thinking ability in mathematics education students. She also acts as an expert/validator in the development of learning strategies and learning media. She can be contacted via email: nurhanurawati94@gmail.com

Nurain Suryadinata, S.Pd., M.Pd., is a lecturer in Mathematics Education at the University of Lampung. He completed his Bachelor (S1) and Master (S2) education at the University of Lampung. He has an interest in the field of learning media and mathematics education. He also focuses on developing learning media designs based on visualization of historical sites. He can be contacted via email: nurain.suryadinata@fkip.unila.ac.id