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The Effect of Guided Discovery Learning Model on Students' Mathematical Representation Ability

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Abstract – This study aims to determine the effect of guided discovery learning model on students' mathematical representation ability. The population in this study were all VIII grade students of SMPN 1 Natar (Indonesia) even semester of the 2023/2024 academic year. The sample is obtained as many as 66 students consisting of 2 classes. This study is a quasi-experiment with the research design used pretest-posttest control group design. The data of this study is quantitative data obtained from the test of students' mathematical representation ability. The data were analyzed using Mann-Withney U test. The analysis of students' mathematical representation ability showed that the improvement of mathematical representation ability of students who followed guided discovery learning was higher than the mathematical representation ability of students who followed conventional learning. This means that the guided discovery learning model has an effect on improving students' mathematical representation ability.

Keywords – Effect Of Model Learning; Guided Discovery Learning; Mathematical Representation Ability

I. INTRODUCTION

Education is a spearhead for a country, and is an interest for a country that wants to grow, advance, and has the right to compete in the global order (Nurfatimah et al., 2022). A country must do its best to implement quality education for the progress and feasibility of the country. The education implemented must be able to prepare students to compete in a global society, with the goal of meeting the demands of an increasingly competitive and developing era (Murtiyasa, 2016). Therefore, students must have ability in the educational process towards the development of this century for all levels of education and all subjects, including mathematics.

Based on Indonesian Government Regulation Number 32 of 2013 which regulates the structure of the curriculum, mathematics is one of the subjects taught at all levels of education and has an important role in the development of science and technology. With the purpose of learning mathematics itself, one of which is mathematical representation (Kemendikbudristek, 2022). In the NCTM (2000) also sets five process standards to meet the needs of students' mathematical abilities, one of which is mathematical representation ability. Thus, from some of these opinions, representation ability is one of the important aspects that must be possessed by students.

Representation is very important and is needed by students because it helps them to understand the material given and is needed in solving problems (Wijaya, 2018a). Representation is the interpretation of the way students think about a problem and use it as a means to help them solve problems, and includes understanding what they can, interpreting images and mathematical ideas in various models through various means (Puspitasari et al., 2019; Sari et al., 2019).Through this mathematical

representation ability, students are able to communicate their mathematical ideas (Astuti & Siroj, 2017a). Therefore, representation ability is an ability that must be possessed by students, because students who have good representation ability can interpret problems in the form of images, symbols, numbers, words, or sentences, so that they become easy to understand and find solutions (Astuti & Siroj, 2017b; Wijaya, 2018b; Miladiah et al., 2020). Mathematical representation skills that must be possessed by students consist of visual representation, representation of mathematical equations or expressions and representation of words or written text (Rangkuti, 2014a).

But according to the PISA results in 2022, Indonesia ranked 68th in mathematics with a score of 366.This result decreased compared to PISA 2018 where Indonesia was 73rd with a score of 379, and based on the results of this PISA survey indicates that students' mathematical literacy needs to be improved (Alghofari et al., 2024). Students' lack of concept understanding is based on PISA questions with the context of the mathematical abilities they solve, which includes indicators of mathematical representation ability (Hamidy & Jailani, 2019). Therefore, it can be concluded that one of the low student achievement lies in the low mathematical representation ability of students.

The low mathematical representation ability also occurs at SMPN 1 Natar. Based on the results of the Minimum Competency Assessment in 2022, it shows that SMPN 1 Natar has an average reasoning ability of 53.97, lower than similar educational units at the national level which is 54.63. The reasoning ability is closely related to students' mathematical representation ability, where the process of learning mathematics students in reasoning and communicating mathematics will use representations in describing the mathematical ideas conveyed. Therefore, in the ability to reason and communicate mathematically, there is a mathematical representation ability in it (Absorin & Sugiman, 2018). In addition, the results of observations made during the preliminary study in class VIII of fraction material containing mathematical representation ability also showed the results that the students' mathematical representation ability were still low. The learning that is implemented at SMPN 1 Natar is teacher-centered learning. This is one of the reasons why students are passive and do not explore information about the material they get (Cahayanti et al., 2013a). Improvement and enhancement of students' mathematical representation ability are needed because of these problems.

The learning that can be used to solve these problems is learning that emphasizes active participation of students in conveying ideas or ideas that they know (Cahayanti et al., 2013b). That way, students who experience this learning will be able to explore their ability to think and solve problems. The application of creative learning models can make students motivated to learn and receive learning well (Habiddin, 2022). One of the learning models that provides opportunities for students to engage in these activities is the guided discovery learning model.

Guided discovery learning is also defined as guided discovery learning, because discovery comes from the word “discover” which means to find and “discovery” is discovery, while guided can be interpreted as guidance or guided.Therefore, guided discovery learning model is a model where students work on their own with the help of the teacher to discover concepts, principles, and theories (Nofiana & Prayitno, 2020a). Guided discovery learning can also mean that students make discoveries and are carried out on instructions from the teacher (Hanafiah & Suhana, 2010). So that in this learning, students are actively involved in obtaining the expected information and knowledge by independently with the guidance and instructions provided by the teacher.

The mismatch between the importance of students' mathematical representation ability and the achievement results is a challenge for teachers. There is a need for learning innovations that can be applied to improve students' mathematical representation ability. This study applied guided discovery learning model with the aims to determine the effect of using the learning model on students' mathematical representation ability.

II. METHODS

This study was implemented at SMPN 1 Natar in the even semester of the 2023/2024 academic year. The population of this study were all VIII grade students who were distributed into eleven classes ranging from VIII A to VIII K. This study used

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purposive sampling technique, with the consideration that the selected classes were taught by the same teacher so that they had relatively the same learning experience. With purposive sampling technique, 66 students were obtained consisting of class VIII I with 33 students as the experimental class that received guided discovery learning, and class VIII H with 33 students as the control class that received conventional learning.

This study is a quasi-experiment (pseudo-experiment) with the design used, namely pretest-posttest control group design. With the data collection technique used is the test technique. The test was conducted twice, namely pretest and posttest. The pretest was conducted before treatment to obtain initial data on students' mathematical representation ability, and the posttest was conducted after treatment to obtain final data on students' mathematical representation ability. The data in this study are quantitative data, namely in the form of student mathematical representation ability scores from experimental and control classes. The data includes pretest score data of representation ability, posttest score data of representation ability, and average score data of improvement (gain).

The test instrument used in this study is a test instrument for students' mathematical representation ability, which is in the form of a description question with a total of 3 questions. The questions were made based on the indicators of representation ability (Rangkuti, 2014b).

Table 1. Representation Ability Indicator

Aspect	**Representation Indicator**
Visual representation	Using geometric figures to clarify the problem and facilitate the solution.
Representation Mathematical equations or expressions	Menyelesaikanmasalahdenganmelibatkanekspresimatematis.
Verbal representation (written words or text)	Solve problems involving mathematical expressions.

Before using the test instrument, it was first validated by the math teacher of SMPN 1 Natar, besides that the test instrument must also meet the criteria of reliability, difficulty level and differentiating power. So that all questions are used to collect data on students' mathematical representation abilities.

After the two samples were given different treatments, the data on the initial ability and the final ability of students' mathematical representation were analyzed to obtain an improvement score (gain). This analysis aims to determine the magnitude of the increase in students' mathematical representation ability in the experimental class and control class.

Data processing and data analysis of students' mathematical representation ability were carried out with non-parametric statistical tests, namely the Mann-Withney U test on the score data of students' mathematical representation ability improvement. Before conducting statistical tests on the score data of students' mathematical representation ability improvement, it is necessary to conduct prerequisite tests, namely normality test and homogeneity test (Yusup, 2018; Arifin, 2017).

III. RESULTS

Student mathematical representation ability test data in the form of pretests and posttests from control and experimental classes obtained were then tested with a normality test. The normality test analysis was carried out to determine whether the data in the two sample groups came from a normally distributed population. The normality test was carried out with the chi-squared test, with a significant level of α = 0.05. The normality criterion is $\chi^2_{count} > \chi^2_{table}$ then the gain data is not normally distributed, and vice versa.

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Table 2. Normality Test Results for Experiment and Control Classes

Class	χ^2_{count}	χ^2_{table}	Test Decision
Experiment	2.889	7.814	Normally distributed
Control	27.762	7.814	Not normally distributed

The normality test results show that in the experimental class the value of $\chi^2_{count} < \chi^2_{table}$ and the control class the value of $\chi^2_{count} > \chi^2_{table}$. The normality test results show that the gain data is not normally distributed. Then the gains data of students' mathematical representation ability were obtained.

Table 3. Recapitulation of Student Mathematical Representation Ability Gain Data

Class	Number of Students	Average	Standard Deviation
Experiment	33	0.54	0.18
Control	33	0.21	0.18

The average gain data of students' mathematical representation ability in the experimental class that followed guided discovery learning experienced a higher increase when compared to the control class that followed conventional learning. Then, for the control class that followed conventional learning did not come from a normally distributed population.Thus, a statistical test was carried out on the study hypothesis using the nonparametric test, namely the Mann-Whitney U test.After processing, the results of data analysis show that at the significance level α = 0.05 the value of $|Z_{count}| = 5.55$ and the value of $Z_{table} = 1.96$.Known test criteria are accept H_0 if $|Z_{count}| < Z_{table}$ and reject H_0 for others. Based on the results of data analysis that the value of $|z_{count}| > z_{table}$, the test decision obtained is H_0 is rejected so that H_1 is accepted.

Because $H_1$is accepted, there is a significant difference between the median data of the improvement of mathematical representation ability of students who follow guided discovery learning and the median data of the improvement of mathematical representation ability of students who follow conventional learning. Then, further analysis was conducted by looking at the average improvement between the experimental class and the control class. It was found that the average increase in the experimental class of 0.54 was higher than the average increase in the control class of 0.21.

In addition, when viewed from the percentage of achievement of indicators of students' mathematical representation ability, it shows that the percentage of achievement of each indicator of mathematical representation ability of students who follow guided discovery learning is higher than students who follow conventional learning.

Table 4. Achievement of Student Mathematical Representation Ability Indicators

Indicator	Experiment			Control		
	Pretest	Posttest	Improved	Pretest	Posttest	Improved
Representation Mathematical equations or expressions	21%	78%	57%	47%	58%	11%
Verbal representation (written words or text)	9%	43%	34%	13%	33%	20%
Visual representation	10%	50%	40%	24%	35%	11%
Rata-rata	**13%**	**57%**		**28%**	**42%**	

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IV. DISCUSSIONS

Based on the research that has been conducted, guided discovery learning requires students to be able to find a concept with guidance provided by the teacher. This learning begins with students' curiosity about the solution to a problem, followed by finding information, and then organizing it into a conclusion. In this learning, students are also required to interact, namely through group discussions. The interaction between students in guided discovery learning occurs with students, students with teaching materials, students with teaching materials and students, and students with teaching materials and teachers (Amini et al., 2022a).

Students perform various activities in guided discovery learning with stages that have been prepared, conduct group discussions and make presentations. In this learning, students are given LKPD to discuss with the group that has been determined. They conduct group discussions to solve a problem according to the information they get and make conclusions. The learning process carried out by students given LKPD, will lead them to find data according to facts, provide explanations, and draw a conclusion as a concept discovery (Samudera et al., 2022). The LKPD contains the stages of guided discovery learning, so that by applying this learning can improve students' mathematical representation ability.

In the implementation of this learning there are stages that are carried out. In order to organize a learning well, there are stages that need to be carried out in a learning process (Warmansyah & Amalina, 2019). The following describes the stages of guided discovery learning that are applied.

The first step of guided discovery learning is stimulation. At this step, students get a stimulus in the form of a stimulus. A stimulus received by students is a problem that they must solve, the problem is a problem in everyday life. In addition to giving problems to solve, students are asked to read the math textbooks they have in the material to be studied in order to get additional information to help them solve the problem. That way, providing a stimulus will have an impact on students to prepare themselves and provide an overview of what they will learn before starting learning, so that they do not feel they will experience difficulties and enthusiasm to start learning. Providing stimulus in learning has its own purpose, namely to encourage and motivate students to learn (Hader et al., 2023).

The second step in this learning is problem statement (problem identification). At this step, students identify problems by observing and looking at the problems contained in the LKPD, where the LKPD is done in groups of 5 to 6 students. Students are given some directions at this stage to get a temporary answer related to the problem they are identifying, and they do it by discussing in groups. When identifying problems, students get an idea of how they solve them and students express them in the form of temporary answers. In this stage, students are required to recall and relate the problem to the concept of knowledge they have had before.

The next stage is data collection. After they identify and get temporary answers related to the problems contained in the LKPD, students collect the information needed by completing each data collection stage in the LKPD as an initial plan in the problem solving process. This information is in the form of data that students collect from LKPD that they complete at the data collection stage, the knowledge they get at the beginning of learning and also associated with the temporary answers they have obtained when identifying problems in LKPD. This activity can help students practice accuracy, accuracy, and honesty, and familiarize students to look for or formulate various alternative solutions to problems.

The fourth step in this learning is data processing. Students process the data that has been collected by calculating the data to obtain answers. Then students check the answer whether it is in accordance with the temporary answer they already have. At this step, students play an active role, namely discussing in groups to process data by applying the steps in the LKPD as well as the directions given.At the data processing step, each student has their own role and helps each other, it can be seen that in processing data there are students who are able to explain to their group members to carry out calculations in order to get the right answer. Because of the group discussion, students can improve social ability in terms of cooperation between students. Because of group discussions, students can share their information, so that the knowledge possessed by students related to the material discussed will increase and can master the mathematical concepts they have learned and be able to improve students'

mathematical representation abilities (Fitriani et al., 2023). The results obtained by students at this stage will be proven through verification or proof activities.

The next step is verification or proof. At this stap, students clarify the results of data processing to the problem solution contained in the LKPD. Students conduct a careful and thorough examination to ensure that the temporary answers they get are correct and connected to the results of data processing. The verification step is carried out through presentation activities and class discussions. One group is appointed randomly to present the results of data processing, then other groups pay attention and compare the results with the results of their own group's work. Each group was given the opportunity to find justification and clarify the results of the class discussion. With the courage of students to present answers to the front of the class in accordance with the problem so that they can get the correct answer is one of the results of applying the guided discovery learning model (Amini et al., 2022b). Thus, this activity can hone students' ability to clarify in the form of sharing information or knowledge related to their hypothesis.

The last step in this learning is generalization (drawing conclusions). At this step by paying attention to the results of verification and guidance given, students make conclusions. Students make conclusions based on the results of the previous verification, each group that has errors in solving problems on LKPD is given the opportunity to clarify and correct their mistakes. The results of the clarification support them to make a conclusion. Thus, the conclusion that students have is a material concept that has been verified (Nofiana & Prayitno, 2020b).

Although each indicator has increased and the increase in the experimental class is higher than the control class, there is one indicator that has the lowest achievement of 34%. The achievement of the indicator in question is verbal representation, most students can write conclusions on solving a problem correctly, but not all students are able to involve the use of words or written text in solving a problem, and the achievement of this indicator is lower when compared to the other two indicators.

Next is the indicator of mathematical expression. In this indicator students are able to solve problems involving mathematical expressions, in solving problems they are able to represent concepts using mathematical expressions by using the right formulas and solution steps. And in the visual representation ability, most students can make a picture correctly to solve the given problem in accordance with what is instructed in the problem, but there are still students who are less precise in presenting visual representations and not in accordance with the problem.

The results of this study provide an explanation that guided discovery learning can significantly influence students' mathematical representation ability with an increase in mathematical representation ability that is higher than students who follow conventional learning.

V. CONCLUSION

The mismatch between the importance of students' mathematical representation ability and the achievement results is a challenge for teachers. There is a need for learning innovations that can be applied to improve students' mathematical representation ability. That is why, this study applied guided discovery learning model in mathematics learning at SMPN 1 Natar. Based on the results of the study, it shows that the application of guided discovery learning model in SMPN 1 Natar even semester of 2023/2024 academic year shows that the improvement of mathematical representation ability of students who follow guided discovery learning is higher than the improvement of mathematical representation ability of students who follow conventional learning model. It is concluded from this study that the guided discovery learning model has an effect on students' mathematical representation ability. Recommendations that can be given to future researchers who will conduct similar studies, it is advisable to be able to pay more attention to student participation and activeness in each stage of guided discovery learning, because it can affect each indicator of students' mathematical representation ability to be achieved.

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